95
165
opy 1
SF95
M65
COPYRIGHT
SEP 24 1877
110124

Meal Feeding and Animal Digestion,

A TEXT BOOK

FOR

ALL WHO FEED CONDENSED FOOD.

SECOND EDITION.

By LINUS W. MILLER,

Author of Notes of an Exile. Design of Creation.

Published by request of the

AMERICAN DAIRYMEN'S ASSOCIATION,

Before whom it was delivered March 14th, 1875.

Price Fifty Cents.

Address L. W. MILLER, STOCKTON, NEW YORK, or M. L. MILLER, 1661 BROADWAY, NEW YORK.

The usual discounts made to the Trade.

Chautauqua Farmer Steam Print, Forestville, N. Y.

Meal Feeding and Animal Digestion.

ADDRESSES

Delivered before the Annual Meeting of the Pennsylvania State Dairymen's Association, at Meadville, Pa., January and December, 1875.

ALSO

Before the Tenth Annual Convention of the American Dairymen's Association, at Utica, NewYork, January 14, (which Convention, by Resolution, Requested the Author to Publish it in Pamphlet Form).

With an Addendum, Giving Instructions for the Practical Application of the Principles Elucidated.

A Text Book for all who Feed Condensed Food,

By LINUS W. MILLER.

(Author of Notes of an Exile, on Canada, England, and Van Dieman's Land, Design of Creation, etc.)

DE PROFUNDIS.

LIBRARY OF CONGRESS COPYRIGHT No. 1877. CITY of WASHINGTON.

SECOND EDITION REVISED, ENLARGED AND IMPROVED.

STOCKTON, N. Y., August, 1877.

Entered according to Act of Congress, A. D. 1877, by LINUS W. MILLER, in the Office of the Librarian of Congress at Washington.

SF95
.M65

PREFACE

TO THE

SECOND EDITION.

The rapid sale of the first edition of "MEAL FEEDING AND ANIMAL DIGESTION," the favorable comments by the Agricultural Press of the country upon its merits as a valuable contribution to agricultural science, and above all other considerations, the uniform testimony of those who have practically tested the new system of wintering stock in its favor, not only as very economical, but as followed by a marked and very important increased milk production in dairy cows, are the chief reasons why the author is induced to offer a new, enlarged, and revised edition of his unpretending work to the Public. He is impressed with the full and mature conviction that as soon as the merits of this new system are recognized as facts, it will be generally adopted, not only by dairymen and herdsmen, but by every man who keeps a cow for milk, in town, city or country; and believing its general adoption will add an immense sum annually to the wealth of the country, he regards it as a sacred duty which he owes to the world in which he lives, to agitate the subject of meal feeding in every proper way, and by all available means, until the prejudices which impede its progress are overcome. If it had been possible for ridicule, malice and abuse to put down this new system, it would have been thoroughly done. History repeats itself. Meal feeding will prove no exception. As far as

it is based upon facts it will signally triumph over all opposition. Upon FACTS the author rests his case, respectfully inviting the unbelieving to tests of his system. The reader will find in this edition a correction of the popular error that meal and other fine food passes directly into the fourth stomach of ruminating animals. The adoption of this popular error was the chief fault of the first edition of "Meal Feeding and Animal Digestion." The author flatters himself that he has done his share towards settling this dispute concerning the use of the several stomachs of the order of animals classed as Ruminantia.

INTRODUCTION.

Millions of dollars are undoubtedly wasted every year, both in this country and Europe, by injudicious feeding of concentrated food to our domestic animals. This assertion may perhaps be deemed extravagant, by the advocates of the old theories; but time alone is needed to demonstrate its truth.

A better understanding of the digestive powers and capacities of our ruminating stock, and the adaptation of certain kinds of food to produce certain results, alone is needed to work a revolution in our whole management of feeding, not dairy stock alone for a few winter weeks, as some have supposed, but in the use of fine food at all times and under all circumstances. Every man who feeds for the production of beef, keeps a dairy or a single cow, in town, city or country, should understand the general principles of animal digestion, as he is liable to throw away his money without knowing it.

He who attentively studies the principles of this unpretending work, will need no apology from the author for the importance which he attaches to it; and he who, from whatever cause, chooses to follow the old beaten track of his fathers, as it is his undoubted right to do, has no business to exact any. The intense interest manifested both at Meadville and Utica upon this subject of meal feeding, where large numbers of earnest practical men from various sections were congregated, and their acquiescence in the general principles laid down in the Address, is a guarantee of the ripeness of the public mind for the reception of truth, no matter what may be-

come of old theories. "This would have saved me *one thousand dollars* last winter, had I known and practiced it," was said to the author by three different persons after the reading of the Address; whiles score named smaller sums, ranging from one hundred dollars upwards, as the measure of benefit which it would have conferred upon them. When, in addition to the exigencies of short hay crops, we take into consideration the daily waste of meal and other fine food, at all seasons of every year, in the production of milk and beef, the magnitude of the interest involved in the aggregate is astounding! Certainly, it is high time that this question is better understood. Personal considerations are of little moment, when such general interests are weighed in the balance; but the author claims the right to say, in this connection, that if in errror as regards the application of any of the principles laid down in this little work, no one can mourn so deeply as himself. The world is full enough of error and false theories already; and his chief ambition is to bear some humble part in their correction.

The criticisms and strictures which have appeared in the agricultural and secular press of the country with reference to "*feeding meal alone*," if collated would comprise quite a volume; and would be chiefly interesting as showing the want of correct knowledge as to the real principles involved, and the absurdities of the old theory as based upon *bulk* and woody fibre. From a mass of strictures, in some of which threats of prosecution under the statute to prevent cruelty to animals is directly hinted, two or three of the most moderate are herewith given as a matter of history.

NEVER FEED MEAL ALONE.

Fine meal, we know, is much more valuable than coarse meal, but farmers do not reach the true reason for the disturbance in the digestive system of the cow from feeding coarse meal. The scouring is caused by feeding the meal alone or unmixed with hay or other

coarse food, which would carry it to the first stomach. When meal is fed alone it goes directly to the fourth or digesting stomach, and not having had the macerating process of the first stomach and re-mastication and mixed with saliva, it is not in a fit condition for the action of the fourth stomach, and will cause scouring, whether fine or coarse, although very fine meal will cause less disturbance than coarse, because the finer particles are more easily dissolved by the digesting fluid, and thus more readily assimilated; but nature intended all the food of ruminating animals to have the macerating process of the whole series of stomachs.

FEEDING MEAL TO COWS.

Eds. Country Gentleman:

In your last issue (March 19th), READER, in his article on winter feed for cows, makes the following assertion: HARRIS LEWIS gravely informed the people of this country that "all the meal they were feeding to cows was being thrown away." This may be a correct quotation from some one of the published reports, and it may be what I said. I would ask Reader, however, if I did not say that I believed the dairymen of Chautauqua county were feeding corn meal at a loss, and that much of it was thrown away? I am ready to accept Reader's understanding of what I did say, and will not deny anything people charge me with.

Reader then goes on to state that the farmers are going to determine the relative value of different kinds of feed for wintering dairy cows. This is just the thing I have often urged dairymen to do, and I rejoice that any man has the independence to step out of the beaten track, as Mr. L. W. Miller has done in this matter. I also rejoice that Reader has opened his eyes to some rays of light which have changed his opinions, similar to those of mine, which he used to hold in regard to the value of corn meal and corn fodder for cows.

If Mr. Miller's experiments with corn meal do not put

his profits for the coming season, and his cows, also, in about the same predicament that the dairymaid's chickens were in when counted so long before being hatched, I shall again rejoice. If Mr. Miller's corn meal diet proves just the food for dairy cows, it will settle one thing forever, viz., that the very best corn lands are above all others *the* lands for dairying, for we cannot on the best grass lands in the United States, north or south, east or west, keep dairy cows for six and a quarter cents per day, on grass or hay, or both, the year through. The cost of keeping a dairy cow at the west, on ten cent corn meal, would be so near nothing that it would be hardly worth naming. If I can keep a dairy cow well on corn meal, I will sell or give away my grass farm, and *go west.*

HARRIS LEWIS.

THE MEAL THEORY.

The meal theory of L. W. Miller of Stockton, by a correspondent of Country Gentleman, is hit off as follows: "I have known a cow to increase in milk by feeding a moderate quantity of Indian meal at regular periods, in addition to other food. But when you talk of feeding a cow three pints of dry meal in the morning, and three pints at night, and no other fodder, "with very little" water, of course there must be some screw loose in the statement. Why, there are some *men* who would use about as much food as that. The six pints would weigh about five pounds (the actual weight is about *four* lbs). Indian meal has about 66 per cent. of fat forming food and 11 per cent. of muscle forming substance. Good hay has about 36 per cent. of the former, and 13 per cent. of the latter. Ten pounds of good hay would be more than equal to the six pints of meal. Yet who ever heard of keeping a good cow on ten pounds daily of hay?—to say nothing of the "very little" water!

FEEDING MEAL.

The Utica Herald notices the report of the experiment being made by Linus W. Miller of Stockton, on feeding

meal alone, and accompanies the report with the following remarks:

The feeding of finely ground corn meal to dairy cows is now being widely considered. Dairymen in this region are now feeding more meal than ever before. The question to be determined is, whether this nutritive material is in a form unsuited to the full exercise of the digestive functions, and consequently, likely to waste its nourishing qualities through imperfect digestion. That it is an unnatural food, that it slips untouched through part of the digestive machinery of the animal, is claimed by some of our most intelligent dairymen. On the other hand, there are many men who feed meal, and think they do so with profit and with good results to the animal.

We are glad that Mr. Miller is making the experiment which is described above. We have little faith in his proving that meal is a perfect and sufficient food; for if his cows maintain their bodies on meal alone, they will perform several creative acts, and creation is not vested in the animal economy. There are materials in the tissues of the body which do not exist in corn meal.* They are not present in it in any shape nor form, consequently the transforming power of the animal cannot act, for it has no material to work over. Again, Mr. Miller is operating in the face of well established beliefs, that a single food is not suitable for maintaining the health and strength of the animal for any great length of time. That Mr. Miller has so far proceeded in his war against nature, that he has succeeded in doing away with rumination in his herd, will startle those who believe in the strict utility of natural processes. But though we are forced to sympathize with Mr. Miller's cows, we hope he will pursue his experiment to the end. We have almost as little faith in his success as in anything we might mention. Feeding meal alone is very different from feeding meal together with more diffuse food. We be-

* What are they?—AUTHOR.

lieve that meal fed properly will do good service, imparting richness to the product and fullness to the form, but a food which leads the cow to forget the cunning of her natural machinery, must seem at the outset to be prejudicial to health and profitable increase. Nevertheless we shall watch Mr. Miller's progress with much interest and attention.

MEAL ONLY FOR COWS.

Eds. Country Gentleman:

I observe that the statement of Mr. L. W. Miller relative to the keeping cows on meal alone, is attracting some attention, and deservedly so. I cannot help regretting that so preposterously absurd an idea, as that cattle can be maintained in health for months together, on nothing but a few quarts of corn meal a day, should be put forth as worthy of trial. The stomach of the bovine is intended by nature to receive a large mass of moderately nutritious food, and it is only when it is properly filled, that the animal can experience the sensation of comfort so essential to health. If Mr. Miller will try the experiment on himself, being contented with three meals a day, each to consist of a single meat lozenge or a teaspoonful of concentrated beef tea, he will experience much the same sensations as his unfortunate cows.* I cannot, however, regard the statement as anything but a hoax. Any one accustomed to cattle knows,

---

* Mr. Miller, along with about ninety other political prisoners, for the offense of trying to give a responsible government to his friends in Canada, suffered the *gnawings* of hunger on a *very empty* stomach for years, in Van Dieman's Land, under *British* rule; and he can tell L. B. L. a tale of horrible suffering, *usurpation* and *cruelty*, that should make a *savage blush* for *shame!* Mr. Miller has no taste for starving even *dumb animals*, much less his fellow men; and if L. B. L. had ever suffered a a little of what those unfortunate prisoners endured, he would not wonder nor take any exceptions to the severity of this note.

that the excessive use of meal invariably results in diarrhœa or dysentery, if long persisted in; and that unless a proper proportion of coarse feed, such as hay, straw or grass is used, the health of the animal is sure to give way. I think the statement in question will be accepted by none but "the marines."

L. B. L.

Sherbrooke, P. Q., Canada.

Meal Feeding and Animal Digestion.

Gentlemen of the American Dairymen's Association:

I shall confine my remarks mostly to feeding Indian meal to dairy stock, when dry, and to their digestion of coarse and fine food. Certain practices of my own in wintering my cows, having attracted much attention and not a little criticism, I suppose you will expect me to explain those practices. Sixteen years ago, happening to mention to a gentleman of my acquaintance that I was short of hay for wintering my stock, he informed me that he had wintered his cow upon three pints of scalded meal, keeping in stall all winter, and watering by hand, and he assured me she came through in good condition, and yielded a fair product of milk that season. Seizing upon this hint of my friend I ventured to place my herd of twenty cows, having first dried them off, upon an exclusive meal diet, feeding an average of three pints, dry, morning and evening, giving the large cows a little more, and the small ones a little less; keeping them in warm, clean, properly ventilated stables, and only turning them out one-half hour each day for water. They were uneasy

the first three or four days of meal diet; but after that had the appearance of unusual quiet and content. I am confident their rations were ample to satisfy the wants of nature, and that they did not lose flesh. The experiment would have been more valuable if they could have been weighed at the commencement and end of meal feeding.

In the spring when they began to drop their calves, I fed them all the hay they would eat in the morning and two quarts of meal at night. But they showed a decided preference for meal over hay. The calves dropped were of the usual size, strong and healthy and gave no indication of a deficiency of proper and essential elements in the food of the mother. When upon exclusive meal diet —a period of nine weeks that season—rumination ceased when they had no longer any food to remasticate. Occasionally one would refuse her meal. It was my custom to administer a tablespoonful of dissolved copperas on such occasions, and a restoration of appetite followed. When the weather was very stormy they were kept in and supplied with water by hand. The amount of water drank at such times was surprisingly small, varying from one quart, in rare cases, to eight or ten per cow each day. I think they would not average to exceed five quarts. Although accustomed to eating a daily ration of salt during the summer, they showed but little inclination to eat it on meal. But when again fed upon hay they at once resumed consuming the usual quantities of water and salt. I made more than the usual quantity of spring butter that season, and when turned out to grass, my cows did better than I had ever known them before, when wintered in the usual way.

After this experience, whenever short of hay, I resorted to meal, feeding in as many winters, five, seven and eight weeks and always with the most satisfactory results; my cows when turned out to grass invariably doing better than when wintered on hay, both as to quantity of milk and a tendency to lay on flesh. In the season of 1873-4, my hay crop was unusually short, and what corn

fodder I had was badly damaged by frost, feeding which, in early winter, my stock were in unusually poor flesh when I commenced feeding meal on the 1st of January.

The result of my experiment I condense from a communication over my signature, published in the *Chuatauqua Farmer* in August last.

"The records of the factory where I send my milk, show an aggregate of 531 cows. There are three herds of cows giving as much, or more than my own the present season—one of them nearly two pounds more daily; but the last sale of cheese of which I have a record, being the make of sixteen days, from June 10th to 26th, credits my herd with giving two pounds fifteen ounces each per diem more than the average of the whole 531. My herd was selected with reference to making butter, not cheese, and I have never regarded them as great milkers; they averaged twenty-seven pounds per diem, for the sixteen days' sale.

In 1872-'73, I wintered my herd upon hay. They came through in good condition, and were fed during the spring months with two quarts of meal daily, and all the hay they would eat. In 1873-'74 I fed for nine weeks (while dry) three quarts of meal; then what hay they would eat and two quarts of meal, for three weeks; then bean vines and meal, for two weeks, losing one of my best cows in the operation of feeding bean vines, and setting the whole herd scouring badly and losing flesh. Then I did what I have never done before to cows giving milk. I fed during the rest of the spring before turning out to pasture, on clear meal, a period of about five weeks, giving five quarts of wet meal daily to those giving milk. Under this treatment they did well, and although the flow of milk was less than when fed on hay, its quality was excellent, and the butter superior. The bean vine butter, however, was poor.

I find, by the factory records, that my cows are giving five pounds of milk each, per diem, more than they gave during the corresponding period last season, when win-

tered on hay. But with this difference in their treatment. This season my hill pasture has been very short during the entire season thus far, although I am carrying four head of stock less than last year, and I have in consequence fed about three quarts of dry bran, per head, to my herd daily. I do not think, however, that this bran would make up the deficiency in pasture as compared with last season.

I fed, last winter, white western meal instead of yellow native corn of my own growing, as heretofore. White Indian corn contains only a fraction of one per cent. of oil, while yellow contains nearly four per cent. There was a marked difference in its effects from anything I have ever seen while feeding yellow meal. The hair first began to look and feel stiff and harsh, then the skin became dry, with the appearance of scurvy, after about six weeks feeding; and finally some of the herd actually broke out with small blotches along the back and sides. I understood perfectly well that a small quantity of linseed oil cake, fed with the meal, would correct all this, and make white meal equal to yellow; but the eyes of the whole country were upon me, predicting failure, ruin and starvation to my cows, and I chose to run the risk of consequences, without any variation from what was advertised; but I shall never feed white meal exclusively again, without adding to it something to supply the deficiency of oil. Hereafter I intend to winter my cows, when dry, upon meal, when I can get it, in preference to hay."

At the close of the season, having fed no bran or extra feed since the 20th of August, I find, by factory returns, that my cows averaged a fraction less than 20 pounds per diem for the season of five months—May 19th to October 19th—being 1 pound 3 ounces each, per diem, more than the average of the 531 cows whose milk was sent to the factory, and an average of four and a quarter pounds each per diem more than they gave for the corresponding season, the previous year, when wintered on hay. I had also two cases of abortion in my herd—the result of acci-

dents—having but one the previous year. The conditions were more than ordinarily unfavorable; but the results were, to say the least, a demonstration of the adaptation of an exclusive meal diet to meet the wants of my animals under the conditions enumerated. Another result of meal feeding I find to be a tendency to lay on flesh more readily than when wintered in the usual manner. I am also satisfied that my herd hold their age better, and that their teeth last longer; the reasons for which are apparent. What the effect would be if wintered continuously for consecutive years on condensed food I am not able to say, never having tested it. But looking to my own profit, as a dairyman, I propose hereafter to feed my cows when dry upon an exclusive meal diet, and also to feed more freely on this article during the spring months. My practice has been to make the change from hay to meal and *vice versa* suddenly without gradation, and thus far it has been with safety; yet prudence might dictate a gradual change when returning to hay; and also care in supplying the animal with the necessary quantity of water for moistening the coarse food. If cows could be watered in their stalls, whether fed on meal or hay, in cold weather, and their stables kept warm and clean, taking care to curry daily at such times, there would be a great saving in food. I would not wish to be understood as laying down the rule that a daily ration of three quarts of meal is sufficient in all cases. Large cattle would require more, and small less. He who feeds meal exclusively should watch his animals closely, and variations be made in the quantity according to circumstances. In very cold weather the animal requires more food, no matter what its nature may be, than in warm pleasant days. The practice of turning out animals in the cold and storms to become chilly, is neither humane nor economical. Regularity in the hour of feeding is also of great importance, whatever the food. It is a law of animal life that the appetite conforms to habit, and that the digestion of food will be more perfect if taken at stated intervals. Where

food of any kind is kept constantly within reach of an animal, it is tempted to eat more than nature requires, and much more than can be properly digested. In feeding meal, whether alone or diluted with coarse food, it is absolutely imperative that it should be ground as fine as for family use; and if from white corn, on an exclusive meal diet, a small quantity of oil meal or cotton seed meal should be mixed with it.

As to the economy of meal feeding, much depends upon the respective prices of corn and hay. The present season corn is high, and hay can be had at a reasonable figure; but when the conditions are reversed, the balance sheet, leaving out the question of increased products, is decidedly in favor of meal. Our farming lands should average fifty bushels of corn to the acre, and our meadows two tons of hay in ordinary seasons. One bushel of corn should last an average sized cow twelve days, when dry. Fifty bushels should keep twenty cows thirty days, where the product of an acre in hay would barely suffice for ten days. The question of labor would vary the result, as well as the value of the manure. I do not claim the facts which I have related as a complete demonstration of the superiority of meal over hay for winter feeding of dairy stock. The known difference in the product of cows in different seasons, without any perceptible cause, renders all detached experiments to a certain extent unreliable. When, however, whole herds show an increased product, it is safe to attribute the change to the causes specified. An experimental farm, like those so ably conducted in Germany, where careful experiments could be conducted for a series of years, testing the relative value of all kinds of food for the production of milk, and the accumulation of flesh and various other desiderata is much to be desired. Nevertheless some propositions have been proved, and some theories exploded, which were regarded as axioms only one year ago; as that rumination is not essential to health in the ruminatia; that it is only natural when made necessary from feeding coarse food; that condensed food may be fed profitably,

and in perfect harmony with nature's laws, without being diluted with coarse food; that *bulk* in food is not advantageous, but the contrary; that nutriment in food, and not bulk, governs the condition and health of the animal; and that condensation of nutriment, and not expansion, is true economy.

Following in the track of this advanced step, are results of vast importance to the dairying interests of the world. The terror of short hay crops, and famine prices, are among the things of the past. By planting more corn, we can keep more cows on our farms; and our brethren in the great corn growing regions of the west, may confidently anticipate an increased demand, and enhanced price for their great staple product. A few remarks upon the digestion of ruminants, and I have done.

Gentlemen, nature has made no mistakes. Her laws are the perfection of wisdom. Design is inscribed in characters of living light upon all her varied pages. The primitive rocks, not less than alluvial soils, bear the stamp of royal laws, harmoniously working out the great problem of existence. The lowest forms of vegetable and animal life are but links of the great chain, stretching from Silurian periods down through interminable ages to the present day. Adaptation to surrounding circumstances, and to the exigencies of life, are clearly discernible in every phase and grade of the animal and vegetable kingdoms. A creature of such vast importance to man as the ruminant, would be an exception in nature. placed, as she is, in latitudes where malignant and blighting frosts and drouths, so frequently cut short vegetation, if she was not fitted to live and thrive, in spite of such adverse surroundings. Her four stomachs are a wonderful adaptation to her wants and necessities under different conditions. In the calf, living upon its mother's milk, we find but slight development of the stomachs used upon coarse food. This fact is important, as showing that concentrated food is not unnatural to the ruminant; complete digestion and assimilation certainly takes place; proving that all the conditions of life are fulfilled in this

order of animals, independent of the use and functions of the 1st, 2d and 3d stomachs. Pardon the digression, in remarking, in this connection, that calves should never be suddenly weaned, but the change from milk or concentrated food, to grass should be gradual; giving time for the gradual development of the necessary machinery for preparing grass, and other coarse food, for digestion and assimilation.

In the full developed ruminant, we find grass, hay and all coarse food, after slight mastication in the mouth, passing into the œsophagean canal or passage on the floor or bottom of which are two doors or openings, the first of which receives all coarse food, and as much water, when the animal drinks, as is required to moisten it. This opens into the first stomach or paunch, which is, so to speak, the animal's storehouse; and which, when herbage is abundant, she soon fills, and is prepared, or rather inclined, from its bulk and weight, to lie down and at leisure finish the work which the non-ruminant is compelled to do as it eats. This storehouse has an opening into the reticulum or second stomach, and by muscular action forces, in small quantities, its contents into it, where, also by muscular force, it is formed into pellets or cuds, and forced through a valve which opens upward, (but never downward) into the œsophagean canal; where, by muscular action, it is forced back to the mouth. Here, at its leisure, the animal remasticates it until it becomes so softened and pulverized, that in the second act of swallowing, it passes the first opening, or door, where, in its coarser state, it forced its passage before; passes the door of the second stomach, which is always closed to food in its downward passage, and enters near the termination of the œsophagean canal, the door of the third stomach. This is the popular theory, but from recent experiments elsewhere related, it is shown to be an error. Thus far the food has been only chewed and softened; but here it is ground. Duplicatures, of the coatings of the stomach are here suspended from the œsophagus, which seize upon the food as it enters, and by muscular

action, file and grind all the coarse parts so that nothing solid or fibrous escapes them.

From the third it passes directly to the fourth stomach, where true digestion begins. The gastric juice here secreted has the power of converting it into a mass called chyme, from which it is changed to chyle. The action of the digestive juices and glands in converting it into milk, blood, and from blood into fat, flesh, bone, muscles, hair, &c., has as yet never been satisfactorily demonstrated.

Modern investigations go to show, however, that slight chemical changes only take place in the food, or the elements composing it, but rather a mechanical change, disintegrating such substances or compounds as the animal's wants require, leaving that which is worthless to be expelled: and that not only ruminants but the whole animal kingdom, are endowed by nature with organs, whose office it is to seize upon the elements required, generally, but not always, in solution in the form of chyle or blood, and with unerring certainty convey them to their destination.

In other words we say nature is conservative of her forces; and in the great chain of life, stretching from the lowest vegetable growth up to man, she appropriates, with the least possible change, the material of the lower to build up and perfect the higher. It is true that nature's laboratory is immense, and her power unlimited, but for that reason we must not charge her with being wasteful. Even cellulose (excepting crude) is not destroyed, but passing through the process of digestion is found deposited in the frame of the eater just, or at least nearly, as it was before mastication in the article of food.

Gentlemen, nature furnishes, in this respect, a pattern for man to follow. Let the dairyman do it and he will get rich. In considering the question of digestion, its proportions are of such magnitude as to forbid any attempt at even a cursory glance at its details in extenso, in this essay. I desire, however, for the purposes which I have in view, to call your attention to certain general

principles involved in the subject of meal feeding, as an exclusive diet, under certain conditions, versus hay. In pushing our inquiry in this direction, we are met at the threshold with certain difficulties in the nature of the animal. For instance, the capacity of our cows to consume any given kind of food materially varies. Cows of equal weight will seldom eat an equal quantity of food. When they do its effects vary and are far from uniform. When the cow gives milk, we find in those of equal weight and size an astonishing variation in both quality and quantity of milk product. One will give four gallons milk per day, and the other but two gallons. The milk of one may be rich in oily matters, and the other in caseine. In other words, there is a marked difference in the proportion of its constituents. Make the milk into butter separately, and we find a difference in color, flavor, and perhaps texture, as well as quantity. If equal quantities of each cow's milk from equal amounts of food were analyzed we should, perhaps, find the result from one as follows: I take, at random, an analysis of milk by J. Alfred Wanklyn:

IN 100 CUBIC CENTIMETRES.

Water	88.43	grammes.
Fat	4.12	"
Caseine	5.16	"
Milk Sugar	4.43	"
Ash	0.76	"
	102.90	

From the other:

Water	90.09	grammes.
Fat	3.16	"
Caseine	4.16	"
Milk Sugar	4.76	"
Ash	0.73	"
	102.90	

Both being the product of the same food in quality and quantity, but from different cows, this conclusion is forced upon us:

1st. As to difference in quantity of milk. The mammary glands of one must have double the capacity of secreting milk which are possessed by the other; or the stomachs of the latter must be sadly out of repair and incapable of performing their normal functions. Upon the last supposition, an analysis of the excrements, solid and liquid, would probably fix the responsibility where it belongs. But we daily find greater discrepancies in the product of cows equally healthful; and we are compelled to look for the cause in the secretive glands of the animal. But the amount of food being the same, we have a right to look for the ingredients of two gallons of milk, stored away in the body of the defaulting animal, and shall not be disappointed, unless there is a want of capacity in her secretive glands to appropriate them. That such is the case, I think no intelligent dairyman, who has given his attention to the subject, will deny. The difference in condition of our good and poor milkers at the end of the season, will not account for the great deficiency of milk. At any rate we do not find its equivalent stored away in the form of fat or flesh. The poor milker is generally in the best store condition, but she ought to be much better than we are accustomed to find her. If we could analyze her excrements, we should probably find the missing constituents.

2d. As to difference in quality; the same course of argument followed out, forces upon us the conviction, that there is a marked difference in the capacity of the lacteal glands in the two animals to secrete the same constituents.

The difference in the fattening qualities of different animals of the same breed, as well as of different breeds, are additional facts pointing in the same direction, and forcing upon us this conclusion, viz.: There is a limit to the capacity of each animal to appropriate the nutritive elements of its food. Hence, if food, we will say meal, is

taken into the stomach, in quantities larger than the various organs of digestion are capable of appropriating its constituents, the surplus is crowded out with the excrements and are lost. An analysis of the manures, solid and liquid, would determine the amount of waste, in any given case. That meal, fed in large quantities at one time, is partially lost, except as manure, is evident; and this accords with the experience of many dairymen who having thus wasted it, come to the hasty conclusion that meal is of little value for food, and that three quarts per diem would be wholly inadequate to supply the wants of an animal.

The gentleman referred to in my opening remarks, as wintering his cow upon three pints scalded meal per day, wintered her the same season that I commenced this practice, upon three quarts; and he informed me she never did better in her milk product than in the following season. Last winter he fed three quarts scalded meal and a small bundle of cornstalks, daily, milking her all the winter and getting a product equal to four quarts per diem, and he says she gained in condition all the time. Col. Potter of Potters Corners, Crawford Co., Pa., informed me a short time since, that in fattening two beeves a few winters since, he began by feeding corn in the ear. Noticing whole kernels in the manure dropped, he turned a couple of small pigs into the stable, to get their living from the droppings of his beeves. He afterwards fed meal in large quantities, and the pigs appeared to thrive better than before; but finding that his cattle did not gain very fast, he reduced the quantity of meal fed until the pigs began to squeal for want of food; but, said he, "my beeves laid on flesh and fat much better than when fed in such liberal quantities."

My own experience teaches me that if, in cows of ordinary size, more than, say from three pints to two quarts is fed at one time, without scalding, waste ensues. That if more is to be fed for the purpose of laying on flesh and fat, the feeding should be, if fed clear, once in six or eight hours, in such quantities as could be assimilated; that if

fed immediately before or after the feeding of hay, in large quantities, a loss ensues from the causes already considered, viz., a want of capacity in the animal to digest only a limited quantity in a given time. In other words, the animal after eating its hay, commences remastication; and the meal commingling with the floating contents of the rumen, each propulsion of the latter into the reticulum causes also an undue propulsion of meal into the demi-canal leading indirectly to the 4th stomach, and an over supply ensues. Which is wasted, hay or meal, it is not worth while, in this connection, to inquire; but one or the other, more likely a portion of both, are forced through the system with the excrements.

That there is economy in cutting and steaming hay is self evident. It has been claimed by able men without being questioned, that nineteen pounds cut hay, in pieces two inches long, is equivalent to twenty-five pounds uncut hay. No nutriment is added by cutting; but so much less work is to be done by the animal, which requires a certain amount of vital force to perform it. This vital force, when used, consumes a corresponding per cent of the nutriment eaten. Therefore a less quantity of food suffices if the hay is cut. If it could, by mechanical means, be ground as fine as the stomachs of the animals grind it, the saving would be in proportion, and probably would not be less than fifty per cent. But the hay thus ground would pass the same as meal, through all the stomachs without remastication.

Why would not this ground hay be a natural food for the cow? It would go just where the cow's Creator designed it should.

Steaming is a step in the same direction, and in some respects its effects would be more advantageous: as, softening the woody fibre, dissolving the soluble parts, and rendering true digestion more easy and thorough. A saving of thirty per cent. is claimed by this process. As no nutriment can be added, the saving must be chiefly in mechanical force. These considerations lead us to the question of equivalents, in the matter of meal *versus* hay.

A common sized animal consumes daily three quarts of the former, or twenty pounds of the latter. In the first the *miller* does the mechanical work; in the latter the *cow*. The miller exacts a tenth toll for grinding your meal, but the cow is obliged to take more than *one-half* for the labor which she performs on your hay! The constituents of meal and hay, when contrasted as equivalents, are liable to more or less error in results, from the fact that the composition of both vary, different kinds of corn yielding different quantities of any given constituent; some being much richer than others, especially in oil, starch and sugar; while hay also varies, according to the soil upon which it is grown, the time of cutting, and the manner of curing; but we are able, nevertheless, to approximate results.

One analysis by Dr. Salisbury of Albany, of corn, gave as follows:

Gluten	4.62
Albumen	2.64
Starch	41.85
Oil	3.88
Caseine	1.32
Dextrine	5.40
Fibre	21.36
Sugar and Extract	10.00
Water	10.00

Or, in other words, of nitrogenous or flesh forming substances about 13.00
Of non-nitrogenous or fat producing substances ... 69.00

This analysis is perhaps as favorable for arriving at an average of the true value of corn for feeding to animals, as any that can be found, except that the amount of woody fibre given is very large.

The result of an analysis of Timothy hay, which is

quite as favorable as any I have been able to find, I give as follows:

Water	14.61
Flesh producing or nitrogenized substances	8.44
Fat producing or non-nitrogenized substances	43.63
Woody fibre	27.16
Ash	6.15

We find the respiratory elements, starch, sugar, &c., an excess of which goes to the production of fat in the animal in much larger quantity in the corn than hay. In considering the doctrine of equivalents in this case, we must look beyond these figures, and take into account the difference in the wants and absolute requirements of the animal upon these different diets. In feeding meal the animal has the three quarts of meal, when introduced to her stomach, to raise to the temperature of animal heat, and say two gallons cold water. per day. This is higher as to water than cattle on meal will average; but I find myself in a situation to be generous in estimates. In feeding hay, twenty pounds per diem, and at least twelve gallons cold water, are to be raised to the temperature of animal heat, and kept there; and not only this, but her first stomach is filled with the food of several days, weighing from 200 to 300 lbs., according to size of animal, which is also to be kept at the same temperature for the 24 hours, wholly at the expense of the 20 lbs. of hay, excepting what heat may be produced by the slight fermentation of the food in that receptacle.

In feeding hay, she must use up from fifty to sixty per cent. of the nutritious elements in her food, to perform the labor of mastication, remastication, carrying so much extra weight in her stomach, and supplying the extra heat.

In feeding meal, the teeth of the animal have perfect rest.

In feeding hay, the teeth are in constant use upon

tough woody fibre, at least three-fourths of the twenty-four hours, and of necessity wear out much faster than when used on tender grass as in the summer season, or when fed upon exclusive meal diet. The stomachs, likewise, have a correspondingly tough job in performing their functions.

But why weary your patience by pursuing this subject further?

Gentlemen, I have proved to you on paper, just as I have demonstrated by my practice, at various intervals for sixteen years, that three quarts of good Indian meal, fed under given conditions, are more than an equivalent for all the good hay you can coax a cow to eat! I am aware that the best known recognized authorities of the world are against me. Galileo's doctrines were not more radical to his contemporaries, than mine are to-day upon this subject; nevertheless, he was right and they were wrong. Theories are sublime fallacies in the history of our race. Guessing, and taking the most important things for granted, has been our bane throughout all the ages. But tests don't lie, and theories have to vanish before them. I quote here from "Milch Cows and Dairy Farming," by Charles L. Flint.

"Now, the normal functions of the digestive organs not only depend on the condition of its food, but on its volume. The volume, or the bulk of the food, contributes to the healthy activity of the digestive organs, by exercising a stimulative effect on the nerves which govern them. Thus the whole organization of ruminating animals necessitates the supply of bulky food to keep the animal in good condition."

The idea is not original with Mr. Flint, who is excellent authority upon many of the subjects upon which he treats, but it has long been taught as an axiom by the very highest authorities. A greater fallacy could not easily be invented. Force an animal to grind up a great bulk of wood fibre, and carry it about with her, to stimulate the nerves of the digestive organs! Why, every motion she makes, outward or inward, is at an expense

of vital force, which is generated by nutriment, not bulk! Alas! poor ruminant; you must chew all day, and you must chew all night, to stimulate the nerves of your digestive organs! Nature cries out in vain for rest and recuperation! Your lord and master says, chew! chew to stimulate your nerves: Nature cries out for nutrition to stimulate your whole system; but man, your lord, gives you woody fibre, bulk, work!

Dairymen, give all the rest you can to your cow, all the year round. When she is in milk if you feed hay, cut and steam and mix a little meal with it if you can; but give her quiet; when you feed green grass in the summer months, cut and carry her food to her in her stall if you can, if you want the greatest possible amount of milk from a given amount of food. If your pastures are short, feed her two quarts of meal in the morning, and let her stand in her stall until it is digested; then turn her out. When she is dry, save your hay for the milking season; fasten her up in a warm, well ventilated stable, and keep her there; give her from one to two quarts of meal (according to her size and richness of meal) at regular hours morning and evening, and a little salt, after the meal, once in two or three days. Carry her what water she will drink (which will be but little); curry her at least once a day. If she is in poor flesh give her a little extra oil meal at noon; do this and she will look a little gaunt and shrunk behind; but stand and look her in the face, which never deceives, and you will see a bright eye, with no hunger in it, and a placid, contented countenance; and when you turn away she will not bawl after you, asking in her dumb way for woody fibre, to grind through her system; do this and she will give you a better return in milk, when you turn her out to grass, than the cow did before, wintered on hay.

Plant more corn, feed more meal, and instead of diminishing your herd gradually, as in the years that are passed away, you may, in the years to come, increase their number.

A new and better era is dawning upon us. The days of famine prices for hay have already passed away, never to return. Let us hasten to learn lessons of wisdom from the errors of the past; let us study the nature and wants of our animals, questioning all theories, demanding demonstration by tests that cannot deceive us; let us acquire new and valuable skill in the manipulations of our milk products, in the manufacture of both butter and cheese; let us educate our sons and daughters to make dairying what its importance demands—a science; let us agitate for experimental stations or farms, which alone can lift agriculture, in all its branches, from its past low estate to the very front rank of all known sciences, where it rightly belongs.

Finally, let us prove all things, holding fast only that which is good.

Exclusive Meal Feeding.

An Address Delivered before the Annual Meeting of the Pa. State Dairymen's Association at Meadville, for the year 1876.

Mr. President and Gentlemen:

One year ago I had the honor of addressing you upon the subject of exclusive meal feeding, as I practice it. The fact that you have invited me the second time to continue its discussion is proof of your appreciation of its importance, and that the determined ridicule which has assailed my theory on every hand, has not prejudiced your minds against it. For this I tender you my grateful acknowledgments. You will find your reward in its practical adoption. That it is to be adopted when understood I cannot doubt.

As dairymen seeking the best methods of feeding for profit, I invite your consideration of such facts as my own limited experience and that of others who have tried my system afford. Inasmuch as it involves a suspension of rumination hitherto considered indispensable, its effects upon the animals thus fed, their milk product, health, length of life, tendency to fatten and the character and quality of their offspring generally, are matters of the gravest importance which call for the closest scrutiny.

The value and weight of my observations you must determine for yourselves. It will take many years of con-

tinued meal feeding to satisfactorily settle all the questions involved in the innovation, but to minds free from prejudice the facts already established are of the nature of demonstrations. Let us examine the facts. For six different seasons during the last twenty years, I have fed meal exclusively to my dairy herd for a greater or less length of time.

The four first seasons were detached, the two last consecutive. During the first my milk was manufactured into butter at home, and was not weighed; but I had occasion to contrast during these years the yield in milk after meal feeding with that after ordinary wintering upon hay, and invariably noticed a perceptible difference in favor of meal feeding, a difference so marked as to render mistake upon the point impossible.

There is a bare possibility that the increase in these cases was accidental, and that the product would have been the same if the previous wintering had been upon hay.

There is always more or less uncertainty in tracing results to their true cause in the matter of milk product in consequence of abundance or scarcity of pasturage.

We can easily regulate and estimate the amount of winter feed, although there may be a great difference in the nutritive value of hay in different seasons, pound for pound, from various causes, but we cannot grade our pasturage or control the season so as to produce uniformity of growth. In comparing the yield of my cows during these periods this uncertainty is entitled to consideration.

Whatever the cause may have been, the fact that my cows always did best after wintering upon meal is indisputable. The calves dropped after meal feeding were larger, stronger and in better flesh than after hay feeding. I submit that this result cannot reasonably be supposed to have been accidental.

Some of these calves I raised, and they are among my best milkers. Whether wintering the mothers on meal had any perceptible influence in developing milking

qualities in the offspring, I am not yet prepared to affirm as established.

Another fact early attracted my attention in the practice of meal feeding, viz: All animals wintered in this way, take on flesh when turned out to grass in the spring more readily than when hay fed.

Again, for the past three seasons I have sent my milk to the Stockton cheese factory for a period of about five months each season where it has been daily weighed.

In 1873 they were wintered upon hay; in 1874 and 1875 upon meal. They averaged for the first season a little more than 16 pounds of milk daily, and this was about their usual yield when wintered on hay; for the second season about twenty pounds, and this year, which is my first of consecutive meal feeding, over 27 pounds daily.

During the spring months before turning to grass, their rations being what hay they would eat and two quarts of meal daily; their daily average of butter when wintered upon hay has ranged from 12 to 14 ounces.

The present season upon the same daily rations, they have averaged during this period, 1½ pounds of butter daily—a gain of 75 to 100 per cent. Their whole product for the season is equivalent to 250 pounds of butter per cow.

Their feed has been the grass of the pasture only. The season was wet and cold; the pasture may have been better than in 1873, but other herds, the milk of which has been sent to the same factory, have shown no corresponding increase of yield. The legitimate inference to be drawn, is that the difference is owing to their manner of winter feeding.

Again, three of my cows proved to be barren last spring, two of which were meal fed with the rest of my herd, but the other was fed what hay she would eat and two quarts of meal daily, and milked for family use till the 10th of March, when she was dried off.

The two meal fed cows were milked till the 10th of January, and had about fifty pounds of meal each, du-

ring the spring months. They were turned to grass with my milch cows, and in three weeks time were beef and sold as such. The one not meal fed had the same fare, ran dry all summer in the pasture and had to be stall fed in October and part of November, and even then was not in as good condition as those that sold for beef early in June.

Whether this remarkable increase of milk production in my herd, and this quick fattening for beef, have any connection with my manner of wintering, you, gentlemen, can judge as well as I. It is possible that the same results might have followed if meal feeding had not been practiced.

It is an axiom with dairymen, that cows well wintered yield larger returns in milk, than if insufficiently fed, and that if allowed to become poor or thin in flesh before dropping their calves, the latter will be inferior, and the milk product for the following season materially lessened.

Cases of retention of placenta have very rarely occurred after a winter of exclusive meal feeding.

Mr. Philip Lazell, the well known butter buyer of Stockton, has wintered his one cow upon an exclusive meal diet, as many seasons as I have my herd; he however, scalding the meal, and has twice fed in this way from November till grass grew in the spring, with satisfactory results.

In the spring of 1860, Mr. Thomas Lyne, a tenant of Mr. Truman Todd, of Stockton, who is widely known as a cattle broker, being out of hay fed meal from March 1st till grass grew—three quarts daily to those not in milk, five quarts daily to the milkers, with this innovation upon my practice, that he allowed his cows to range his fields when the weather was favorable instead of keeping them closely in the stables. His herd made more butter that season than they had ever done before.

Mr. Todd informs me that being satisfied of the desirability of meal feeding, he had since then repeatedly urged upon his tenants a renewal of the practice, but they were unwilling on account of the popular prejudice

against the smallness of the ration, and the suspension of rumination.

Since the public agitation of this subject, so strong has been the prejudice against it that but few have had the temerity or the independence to test the merits of the practice. All the cases reported to me, however, have been witnesses in its favor.

Mr. Wm. H. Whitney, of Bladensburg, Iowa, writes me that he fed four two-year-olds last winter, according to my rule, which fattened very quickly in the spring when turned to grass. He appends this remarkable statement that during a residence of eight years in that great corn-growing State, he has never heard of another instance of fattening cattle upon meal.

Wm. Beadle, Esq., of Cadiz, Ohio, in a letter to the New York Times, gives his experience in wintering two of his herd of cows, feeding under my rules for ten weeks, and strongly endorsing the practice as a great improvement.

In a recent letter received by me, he says: "These cows have done full as well if not better than the rest of my herd running in the same pasture, but wintered on hay." He also commends my rules of feeding as laid down in my pamphlet.

John Adams, Esq., of Ingersoll, Ontario, Canada, wintered a large herd of fifty cows according to my system. He writes me that the winter was the coldest ever known in that region, that his stables were very cold, and that in consequence he increased the ration to an average of four quarts daily; that upon this ration they did not scour; that they went through to grass all right, came in all right, and at the close of the milking season, says they have never done better; and that meal feeding was a great saving to him, both of time and money.

You will perceive that this test of my system by Mr. Adams has great value, at least in two respects: 1st, it shows that the meal ration can and should be graded by the wants of the animal. The intense cold demanded a corresponding increased ration of heat producing food,

and the needed supply of carbon was readily found in the meal.

Could an equal amount of carbon have been found in any hay ration that the cows could possibly have eaten if the labor of the animal in its consumption be considered?

Had the weather been still colder, the animals would have required still more, and it would have been perfectly safe to have fed them accordingly. Ten degrees further south 2 quarts would very likely have met the animals' wants as fully as the 4 quarts at Ingersoll.

The Greenlander readily consumes his 6 or 8 quarts of whale or seal oil per day, the inhabitant of the Temperate Zone his pound of meat and one or two pounds of farinaceous food with condiments, while he of tropical climes is content with his ration of rice and a few simple fruits.

All animal life is subject to the same laws, and only uniform under the contingency of like conditions.

2d. Mr. Adams has shown that meal feeding can safely be followed in the coldest regions, wherever it is desirable to domesticate the cow or a sheep. The importance of this fact cannot well be over-estimated, and the lesson which it teaches should be heeded.

Gentlemen, I have given you the facts bearing upon my system of meal feeding, as I understand them, in the plainest possible language, without coloring or exaggeration. My firm belief is, that the system tends to develop the milking capacity of cows thus fed, and that all ruminating animals will fatten quicker and cheaper under this than any other known system. The demonstration of this is within easy reach of any who may elect to test it. Beyond all question, the proofs are conclusive, that three quarts of corn meal, fed in accordance with my rules, is fully the equivalent of twenty pounds of the best hay as ordinarily fed by our dairymen and stock raisers, and that, if necessary, hay may be entirely dispensed with, in wintering dry stock or sheep with perfect safety.

One bushel of corn ground and tolled will last an ordinary sized cow of 900 pounds weight, 12 days, and is equal to 240 pounds of hay. Corn at 60 cents per bushel is the equivalent of hay at $5 per ton of 2,000 pounds, and where it can be had at that rate the cost of wintering an animal, weighing 900 pounds, will range from $7 to $10, according to coldness and length of the foddering season.

But hay, as a rule, costs at least $10 per ton, and frequently, in many localities, ranges from $15 to $25. The saving effected, by adopting my system, will be from $5 to $20 per animal, according to the respective prices of corn and hay. In seasons of short and defective hay crops, which are becoming more common, the importance of meal as a substitute for hay is apparent.

As a deficiency of the corn crop seldom, if ever, occurs in connection with that of hay, there can arise no necessity hereafter for sacrificing our animals for want of food.

In these times, when economy in every possible way, with very many, is both a necessity and a duty, meal feeding commends itself to all who are desirous of saving their money.

A new and probably permanent market is opening for American beef in England.

The price of corn in many western States ranges from ten to twenty cents per bushel.

Corn and grass, either separate or combined, produce the richest and cheapest meat, as they do also the best and cheapest butter and cheese.

The poor man, who keeps his one cow, in town, village or country, can winter her safely in spite of $20 or $30 hay.

This may not please those who make a business of selling hay, but they will have to accept the inevitable, and be content with more reasonable profits.

But I am speaking to dairymen who are dependent upon their herds for their living. Your business will become much more profitable if you avail yourselves of the advantages of my system of feeding.

Many will find it very convenient to adopt in consequence of a disproportion between their meadows and pasture lands.

Meal feeding will enable all of you to increase your herds and keep any portions of your lands under the plow.

In my address before you one year ago, I assumed the direct passage of meal fed to ruminants to the fourth stomach. This has been almost universaly conceded in this country for the last fifteen or twenty years.

Our most distinguished agriculturists claimed to have demonstrated the fact contrary to the observations of the French scientists.

During the past season I have slaughtered two meal-fed beeves, and an examination of the stomachs has shown an accumulation of a number of days rations in the rumen. This is conclusive testimony as to the passage of the meal. I found also that, like coarser food, it passed into and through the third stomach.

Feeding meal immediately before the animals were killed, I have also made very careful examinations of all the stomachs of a large number of beeves fattened in the ordinary manner.

The great mass of the meal so fed has also been found in the rumen, with only very slight traces of it in the third and fourth stomachs, where it was probably carried prematurely by the violent death struggles of the animals.

As my rules for feeding are founded not upon theory, but upon practice, I find no good reason for their modification, in this discovery, except perhaps to emphasize the necessity of allowing animals fed under my system all the water they may wish to drink, otherwise if feeding heavily, there might be danger of impaction of the manifolds.

Gentlemen, when this agitation first began, the whole world was arrayed against me. The harmless suspension of rumination and the small ration fed were held to

be *prima facia* evidence of the torture of my animals, and their slow starvation.

I was arraigned at the bar of public opinion, accused of either wanton cruelty to dumb beasts, or of falsifying facts. The most ignorant were loudest in their denunciations, but many who assume to be teachers in agriculture encouraged them.

My accusers in many instances, were those who claim to speak in the name of science, as Galileo's claimed to represent the Bible. History repeats itself; the conditions are similar, but I shall sign no recantation from fear of being torn limb from limb.

All reforms and discoveries pass through three stages, viz: Ridicule, discussion and adoption.

There seems to be a lull in the cyclone of ridicule, and for the credit of this generation it is to be hoped the storm is over.

Discussion so far has been in the form of assertions, generally affirming the infallibility of German scientists, whose experiments in feeding, so far as they go, are in no respect antagonistic to my system. Facts will in time elucidate themselves. The explanation of my system involves a more intricate knowledge of physiological laws than prevails among those who assume to speak in the name of science.

Let me be understood. Those who are entitled to the appellation of scientific men have not yet spoken, as I am aware, with the exception of Prof. Johnson, and he treats the subject with all the candor that has ever marked his able writings.

In the future I hope, if my life is spared, to be able to satisfactorily solve some of the problems involved in my system of meal feeding. A thorough investigation of its merits is now in order. When once understood, its universal adoption is inevitable.

Meal Feeding.

ROCHESTER, N. Y., November 1st, 1875.

O. C. Blodgett, Esq., Cor. Sec'y Western New York Dairymen's Association:

SIR:—Will you, or your society, please take very careful notes of the result and effect of exclusive meal feeding to cows this winter in L. W. Miller's experiments?

Note the appearance and behavior of the animal in every particular, also her appearance and weight at the time of going on to meal as compared to the same at the end of such feeding; to the end that you may have some information as to whether she has gained, held her own or lost flesh during the time. Also please report any points of interest that you may observe about them.

When you or your society have completed your observations, please state what value this method has, and in what manner you would apply it in practice upon your farms. Yours, truly,

(Signed) L. B. ARNOLD.

Upon this suggestion the president appointed a committee to take observations. They were composed as follows: E. L. McCullough, chairman, Stockton; Dr. Geo. S. Harrison, Sinclearville; Philip Lazell, Stockton; Dr. D. G. Pickett, Stockton; Chauncey Warren, Stockton; O. C. Blodgett, Pomfret.

REPORT OF MEAL FEEDING COMMITTEE.

To the President of the Western New York Dairymen's Association:

Your committee appointed to note the result of exclu-

sive meal feeding to dairy cows, respectfully report as follows:

We have from time to time visited L. W. Miller's herd of dairy cows in Stockton, N. Y., during the winter while being fed on meal, and after they were put back again on hay.

They are for size and general appearance about an average lot of Chautauqua county native cows; average live weight about 900 pounds.

The herd were fed exclusively upon corn meal for 7 (seven) weeks; each animal according to its digestive capacity, making an average of about 3 (three) quarts of meal per day for each cow.

During this time the following points were apparent:

The cows did not ruminate. Were very quiet; did not evince any inordinate desire for food when hay was shown them; not so much as is displayed by cows that are fed on hay alone, in the usual way of feeding, a little less than they will eat. Were much more quiet than cows fed mostly on meal with a small feeding of hay; say 4 to 5 pounds per day. We could not discover any signs of suffering or unrest in any way whatever.

That by comparing their condition at the time of going on to meal with their condition at the time of going back again to hay, we could not discover that they had either lost or gained in weight of flesh. That visiting them again after thirteen days on hay we could not discover anything about them that would denote but that they had been wintered in the usual way; were then filled up again like other cows; their stomachs sufficiently distended for digesting hay and were ruminating in the usual manner.

We also find that the calves dropped from these cows are of more than ordinary size, fleshy, strong, active and healthy, and that in parturition, cases of retention of the placenta are unusually rare.

That these cows have been treated in this way for several winters at a greater or less length of time each year, and by referring to notes from cheese factory records,

we discover that they sometimes produce more milk per day than any other herd; last July, for instance, being a daily yield per cow of 29 lbs. 3 ozs., or 1 lb. 11 ozs. per cow more than any other herd.

From affidavits placed before us by persons who have observed the point in years past, we find that such meal fed cows, when turned to grass, take on flesh faster than those wintered in the usual way, other conditions being equal.

Signed—E. L. McCullough, Philip Lazell, Chauncey Warren, D. G. Pickett, Geo. S. Harrison, O. C. Blodgett.

JAMESTOWN, N. Y., May 10th, 1876.

PROF. L. B. ARNOLD:—I herewith hand you report of committee on meal feeding on the "Miller plan."

Let me say that I have met with them several times, and I fully concur in their report.

You ask us the question, "How will we apply this method to our practical business?"

I will answer by saying, (1) should I find in the fall of 1876, that I lacked feed for my thirty or forty cows for thirty or forty days, I should not sell off a per cent. of those cows; nor should I buy hay; nor should I cut down on their daily feed of hay and add a little daily ration of grain to make it "go further;" but when my cows were all dried off, should keep them all on meal exclusively for the thirty or forty days, and then go back to hay again. Other ways of making this method useful to us will readily occur. Thus we may keep more stock with a given amount of meadow land, or we may utilize the corn crop in the place of hay at any time when the meal would be cheaper than hay. Many ways will occur to us how to utilize a fact in nature when it has once been discovered.

Again, should a June frost sweep off 70 per cent. of our hay crop as in years past, our 50,000 cows would not be sacrificed down to a minimum, but they would be all carried safely through. I am of the opinion that

when Mr. Miller's rules are followed in this matter as laid down in his treatise on "Meal Feeding and Animal Digestion," that not only is meal feeding cheap, safe and reliable, but we have some evidence to show that the treatment goes to improve the after milk production of the cow. On this point please let me remind you that this Miller herd of cows, although only an average lot to appearance, often outstrip the premium herds of Stockton, in quantity of milk given the summer after being fed on meal. Of course other causes may produce this result. They may have better grass, (not very likely), or they may be milked with more precision and treated more kindly, (not probable), or perhaps they would beat the other herds under exact like surroundings; but the fact at least does not argue that meal feeding is detrimental to after milk production. On this point we have the result of Thomas Line's experiment, that also points in the same direction. He fed a herd of cows on meal exclusively from about March 1st, till grass grew. The result was that the cows gave a large yield of butter the following summer. Therefore putting the results so far obtained all together, we can not well resist the logical conclusion that exclusive meal feeding has a tendency to influence both the animal after milk production, and her capacity for laying on fat when changed back to other feed. Other questions occur in this connection. What would be the result on her length of life if this course was followed every season? Would she live a greater number of years or would she die younger? What would be the effect upon her race if they were kept in this way for a number of successive generations? Would you thereby build up a breed of better milkers, or would they deteriorate after the first generation in their milking qualities? It is quite an easy matter for a class of minds to settle all these questions beforehand by a system of guessing; or as we might say, "deciding the case before the facts are all in." In order to bring in the facts I hereby suggest that Mr. Miller continue to pursue this course, and to raise calves from such cows and in turn the calves

again from them, and in this way settle the question not only as to what the immediate but also the remote effect may be upon such a race. These and many other points are liable to be brought out, following the first discovery of the main fact; namely, that a ruminant may be fed in such a way as to suspend rumination for a time without detriment to the animal.

In the future there will be a great number of animals kept in this manner in this county, and our opportunity for observations more extended; and I shall take great pleasure in assisting to carry out any system of taking such observations as you may suggest.

Yours, respectfully,

FLINT BLANCHARD.

To Prof. L. B. Arnold, Sec'y American Dairymen's Association, Rochester, N. Y.

ADDENDA.

Containing Rules and Explanations, for the Practical Application of the Principles Involved in the Foregoing Address.

FOR AN EXCLUSIVE MEAL DIET.

The stables should be warm and comfortable, securing protection from the rigors of winter. Light and air should be freely admitted when the temperature will permit; sunlight should never be excluded from our animals, unless it involves the admission of cold winds. The platform upon which they stand should be dry, and if covered with refuse straw, or forest leaves, gathered for the purpose, it will add to their comfort, securing better results for the food consumed, and a valuable addition to the manure pile. Dairy cows should be first

DRIED OFF,

before they are restricted to the limited quantity of food recommended. If any of the herd are to be kept in milk, they should be placed by themselves, and out of sight of the others if practicable, and fed accordingly upon both hay and meal, or other coarse succulent food. If however coarse food is wanting, and milk is desired, the animals may all stand together as usual, and those in milk fed according to directions given.

OVER FEEDING

is to be guarded against as indispensable to success. The

mangers or troughs, in which the animals are to to be fed, must be arranged so as to render it impossible for any of them to obtain, by overreaching, any part of the portion fed to their nearest neighbor. Feeding troughs are not a necessity in meal feeding. The mess may be eaten from the smooth floor, in front of the animal, or any convenient vessel, movable or otherwise; but as some will eat faster than others, they will infringe upon their neighbors' rights, unless prevented by a partition which renders it impossible. The usual distance between the stanchions in the common American stable where hay is fed, is not sufficient, without partition or other effective barrier. The damage to the animal robbed of a portion of its daily ration, bears no proportion to the injury inflicted upon the trespasser. Scouring, which is most zealously to be guarded against, is sure to result if overreaching is practiced.

THE MEAL

must be ground as fine as possible. Scouring is liable, if it is fed coarse. The gastric juices perform their work upon fine meal readily; and if the quantity fed is not too large, not a particle can escape their action. If coarse meal is, from necessity, fed, it should be thoroughly cooked or steamed, which alone would render it equal to fine. In case it was desired to lay on flesh or fat, either to improve general condition, or to make beef, the quantity might be gradually increased, if cooked, with but little, if any, danger of relaxation of the bowels. The corn used should be of the yellow variety, unless

OIL CAKE OR COTTON SEED MEAL

is added. There should be from three to four per cent. of oil in good sound yellow corn (white corn although it may be rich in starch and sugar seldom contains even one per cent. of oil). This proportion of oil in their food should never, under any circumstances, be diminished, but may with safety be increased fifty per cent.; and if beef is desired, the quantity may be doubled. The feeding should be at

REGULAR HOURS

if possible. Habit governs the appetite and wants of the animal, to a much greater extent than is generally understood. Quiet, which is essential, if the best results are desired from a given amount of food, can never be secured unless the hours of feeding are regular and uniform. Twice a day, not far from sunrise and sunset, with an average of about three pints to one feed, has been the author's rule; but, if convenient, dividing the meal into three messes instead, might insure better digestion with some animals, and also obviate some of the dangers of relaxation. As a rule, the meal when fed to cows *not in milk* should be

DRY.

The animal has an abundance of saliva, which is better than water to moisten it, and which otherwise will be partially wasted. The dryer the food, the longer will be the process of moistening it with the secretions of saliva. As these secretions are natural, the presumption is, that their agency in preparing the food for the action of the gastric juices, and other acids employed in the different stages of digestion and assimilation, may be essential. As over-feeding is most rigidly to be guarded against, an

EXACT MEASURE,

holding three pints (if feeding is to be twice a day, or one quart if three times) should be used, that no mistakes may occur. It cannot be impressed too strongly upon the mind, that success in meal feeding depends more upon this *one little item*, than perhaps many others combined. The meal MUST be fed in *small* quantities. Relaxation, which may prove difficult to control, is sure to follow if due heed is not paid to this point. For the same and other obvious reasons, the feeding should be done, if possible, by

THE SAME HAND

from the beginning to the end; and this should never, under any circumstances, be left to a careless or incom-

petent person. The animals will require watching closely, and no one should have charge of them, unless he feels interested in carrying them through in the best possible condition. One ounce of *prevention* will be found of far greater value than a *pound* of cure, in feeding meal.

THE CHANGE

from coarse food to fine, had better be made at once, without any gradations. It takes a number of days for the first stomach to become quite empty, and remastication of the coarse food previously eaten will continue more or less until this is accomplished. The meal fed goes at once into the rumen, and if the quantity for the first two or three feedings is not small, an over supply ensues; at all events it is mixed with the coarse food previously eaten, until the supply runs out. For this reason the change cannot be made suddenly, if it was desired, and the feeder must use his judgment at first, rather than his measure. Besides, if the animal is unaccustomed to eating meal, three pints would be likely to produce satiety at first, even if it did not affect the bowels unfavorably.

The absence of the weight and bulk of the coarse food, and the necessary gradual cessation of rumination, involves more or less uneasiness, on the part of the animal, for a few days. It is simply, however, the breaking up of an old habit, and the formation of a new one in its place; and perfectly in accordance with nature, and the laws designed for the well-being of ruminants. The passage of fine food directly into the rumen, is of itself a full and complete answer to any and every assertion and argument, that meal is an unnatural food; or that its exclusive use involves any actual suffering whatever. The animals had better be kept in their stalls, and watered by hand, until they become quiet and contented. If accustomed to the change of diet, they accept the situation very quietly. For several winters a stranger daily visiting the stables of the writer, would scarcely have noticed anything unusual in the appearance of his herd, when

the change of diet was being made, unless it was the natural shrinkage in bulk. This shrinkage soon becomes marked and prominent, and, to one unaccustomed to seeing animals in that condition, might cause him to regard them as wasted and poor, when in reality they were the reverse. The animal, relieved from carrying a large bulk of matter (amounting in an aggregate to from one-fourth to one-third of her live weight) and the by no means insignificant labor of remastication, soon learns to enjoy her new life. The old habit might incline her to seek bulky food, if she had the chance, but the better way is to keep such food out of her reach, compelling the formation of new habits in accordance with her changed condition. The same hand that feeds the meal should

CLEAN THE STABLES,

or at least examine the manure of each animal as often as he feeds. This he should never neglect, until his animals have become accustomed to the new diet, and their discharges become natural, showing regularity and perfect digestion. The amount of meal fed when this occurs shows the digestive capacity of the animal; sometimes this digestive capacity is gradually increased, in which case the rations should be correspondingly increased. Upon his care and discrimination in this matter will depend his success in meal feeding. The manure dropped for the first few days will vary more or less, being composed, in part, of the contents of the coarse food previously stored in the rumen. If any tendency to relaxation is shown, scald the meal, or lessen the amount fed. When the old food has been evacuated some animals will go one, two, and even three days without dropping any manure whatever. This is no cause for alarm, but is an indication, if the appetite is good, that the ration of meal may with safety be slightly increased. If however the appetite is poor, and a reluctance is shown to eating, try if scalding the meal will not better meet the requirements of the animal's taste. No harm will ensue if the ration is withheld for one or two feedings, or

even more. It is always safe to underfeed, but *never to overfeed.* In nine cases out of ten, they will resume eating their rations when they get ready, and appear to be better for the season of *fasting.* If, however, the case is obstinate, a tablespoonful of copperas may be dissolved, and poured down the throat. A marked difference will be observed in the appetites of a herd of cows for this diet, which generally, but not always, conform to their

DIGESTIVE CAPACITY;

that is, those that eat meal with the greatest avidity, are generally able to digest their rations thoroughly. Again, as a rule the best milkers will be found to be the greatest eaters, but in this there are exceptions. The animals being dry, the mammary glands are at rest, unless, indeed, they have the power to lay up stores of fat, to be used afterwards in the production of rich milk. The animal having become accustomed to a meal diet, which will be shown by the regularity of its daily evacuations, it becomes important to learn its actual digestive capacity, which may always be done, by closely watching the manure dropped, and conforming the amount of the ration to its distinctive characteristics. When, as will frequently be the case in a herd of cows thus fed, the manure of any animal assumes a whitish mealy appearance, and is soft and watery, the rations are too large, and should be gradually shortened until the desired condition of the droppings is reached, which should be about *three* (3) evacuations daily, of the color and consistency of ordinary winter manure. If

COSTIVENESS

ensues upon the feeding of a given ration to an animal, the manure will be rarely dropped, and always hard, dark colored, and expelled in small round balls. In such cases the amount of the ration should be gradually increased, until the desired regularity and consistency is reached. This condition however is sometimes occasioned by want of exercise, and care should be used in increasing the ration of meal. One half hour each day,

when it is ordinary winter weather, for drinking and out door exercise, will obviate costiveness from sedentary habits. If the animal can be thoroughly curried daily, and watered in the stable, the effect of the food eaten will be much more satisfactory than if allowed to run out in the cold for a longer period. In case, from any cause whatever,

SCOURING

actually sets in, the ration should be withheld, or the meal thoroughly cooked; and this should be persisted in until the bowels become regular. If the case is obstinate, feeding scalded milk is one of the safest remedies known. The juice of hemlock bark boiled until strong, or of the root of the common sumac, is sometimes used with success. The animal loses flesh very fast when in this condition: and no pains should be spared, either to save her from getting into it, or curing her at once, when unfortunately in. Some cows will digest much more meal than others of the same size, and a ration that would cause costiveness in the one, might prove the occasion of scouring in the other, but such are extreme cases, and rarely occur. A perfectly safe remedy when an animal is found incapable of eating, without scouring, is to

SCALD THE MEAL,

and persist in the practice, increasing the quantity until her wants are fully satisfied, and improvement in condition is manifest. He who feeds meal intelligently, will soon learn, that each of his animals has a capacity of her own, for the digestion of her food, which is irrespective of size, weight or general condition as to flesh; and to this he must conform; and he will find the amount required to meet the wants of any given animal can be determined by no fixed rule, but is learned by close observation. Digestion, and the assimilation of the elements of food, are mysteries which science has never as yet been able to unfold. Unseen and invisible agencies silently work out their mission, under the fixed and uni-

form laws of nature, within all living beings. If we knew all the mysteries of digestion, it would enable us almost to baffle death itself, in the human family, prolonging our lives beyond the limits of the patriarchal age; and empower us to make greater improvements in our domestic animals than the wildest visionaries (*generally falsely so called*) have ever dared to predict. Science is gradually but surely working out the great problem. Professor L. B. Arnold, who needs no eulogy from me, for all his writings and works praise him, under date of February 4, 1875, writes me as follows:

"Analysis of the various digestive juices is of little account. The recent investigations in the physiology of digestion, in which I have taken an active part, show that all the changes involved in digestion are of a fermentative character; *i. e*, they are carried on by the action of ferments, and chemists in analyzing the juice invariably kill the ferment, and thus put out of sight the very thing they are looking for.

It has recently been proved, that saliva acts as a yeast, and multiplies its power the same as any other leaven, * * * I have fully demonstrated, that gastric juice acts also as a yeast, and that the ferment may be multiplied and carried from day to day, as a housewife continues her yeast: and have also done the same with sections of the intestines and bladder. The efficacy of the pancreatic juice lies also in a ferment, the power of which is capable of being extended from batch to batch; that is to say, a certain quantity of pancreatic juice is capable, in a given time, of converting a given amount of starch into sugar, and after having done this (all it was capable of doing in a given time), it can then be used again to convert another portion of starch into sugar in an equal length of time."

This limit to the capacity of the digestive organs and agencies should always be borne in mind, in feeding concentrated food. In the remastication of coarse food, nature provides a feeder, which is never at fault in this respect at least, for the food passes in small quantities,

under the action of the digestive juices: coarse food also lies in the first stomach or rumen for days, before it is remasticated; and without doubt, becomes partially fermented prior to its passage into the region of the digestive secretions; the same fermentation takes place with the meal, and the quantity fed at one time must be small if waste is to be avoided.

IN FEEDING FOR FATTENING

this should be borne in mind. The large quantities of concentrated food usually fed must of necessity be in a great measure lost. Not over two quarts of such food should ever be given at one time, and three feedings in twenty-four hours, if coarse food is given also, would certainly be the full extent of almost any animal's digestive capacity. It is impossible, if coarse food is given liberally, to prevent a waste of meal unless the quantity is small. In wintering

YOUNG STOCK, CALVES, ETC.,

it is a question to be determined by long experience, whether an exclusive meal diet would be advantageous to the full development of the stomachs of the animal. Ordinarily, if any organ is not in use, it ceases to develop and grow, and it may be found that young stock, which have not arrived at maturity, will have small and defective rumens, as far as capacity to hold a large quantity of coarse food is concerned, if fed for any considerable length of time on clear meal. A portion of meal daily, and a ration of coarse food, would seem to be safer; but actual tests are better than theories. In changing

FROM MEAL TO HAY,

which should always be done if possible with dairy cows, when they commence making bag, it is desirable to do it gradually. The conditions are reversed from what they were in the stomachs of the animal, when the change was made from hay to meal. Then the rumen was full of coarse food, but now it is empty. It has been the expe-

rience of the writer, that animals once accustomed to meal diet, greatly prefer it; at any rate they generally refuse coarse food at first, and the very best of fresh hay has little power to tempt the appetite. It takes days, more or less (according to size and appetite of the animal), to fill the first stomach so that she will commence remastication. Unless a portion of meal was fed during this period, hunger and suffering must of necessity ensue, for there is positively no digestion and assimilation of the coarse food while it is in the first stomach and previous to the resumption of remastication; except the starch and sugar released by fermentation. Wetting the hay with a little brine, or steaming it, might tempt the appetite of the animal to resume the discarded habit of *going to work* upon coarse food. Care should also be taken to feed all the salt that an animal will eat with relish, while this change is going on, and especially water, and this should always be done summer and winter. If she is fed daily with a portion of meal, that will be evacuated as before the change; but no hay manure can be dropped until after rumination has begun, and the food has had time to pass through all its accustomed stages. When the cow drops her calf, if, as is sometimes the case, hay or coarse food cannot be obtained, the animal can be kept entirely upon meal, even while giving milk; but it is to be justified alone upon the plea of necessity, and practiced with caution. Generous feeding of all the nutritious and succulent food which she can be induced to eat, should be the rule, after three or four days from parturition. It will be found that she will bear from five to six quarts meal daily under her changed conditions, without causing scouring, and it may be even more; but it might be advisable to wet or scald it. The mammary glands, which were dormant before, now act with renewed force and activity; this activity gradually diminishes as the months roll on. The flow of milk will not be large upon clear meal, but its quality will be excellent; and if made into butter, the amount from a given quantity will be satisfactory. It has been the invariable

experience of the author, that cows wintered in this manner yield a larger

FLOW OF MILK

when turned out to grass, than when wintered in the usual manner upon hay and ordinary coarse food. The reasons for this result he does not venture to give, as they would be only his opinions founded upon theory, but the fact is indisputable. Another sequence he has noticed, which is a remarkable tendency

TO LAY ON FLESH.

This is so marked, that the past season some of his cows, giving a good flow of milk, have been fit for the butcher as early as the month of August; a circumstance which he certainly never knew to occur with cows in milk, which were wintered on hay. The dairyman not unfrequently has in his herd cows that have an exceptional value, either as great milkers, or as giving milk of peculiar richness and color, and which are very valuable in giving tone and color to his whole dairy product. The usefulness of such cows

CAN BE PROLONGED,

even after their teeth begin to fail, by feeding more meal during the winter months and less coarse food. Hay, corn fodder, and all kinds of straw, no matter how early cut, or how carefully cured, has a coating of hard woody fibre, requiring *good teeth* for mastication and remastication. If such food is given to an animal with poor teeth, it will be found impossible for her to thrive, and lay on flesh; but if thoroughly steamed and cooked, the case is different; it being by the process rendered fully equal in digestibility to the young and tender grasses of the pasture. But, where steaming is impracticable, Indian meal (cooking will not hurt it), oatmeal, bran, brewers' grains, linseed oil cake, or cotton seed meal, fed in suitable combinations in suitable quantities, may take the place of all coarse food; and the animal kept much longer than is possible on hay and the usual treatment. Such animals

should have meal all the year round. A vast amount of food is lost, except as manure, every winter, by

OVER FEEDING

for the production of milk, to supply our villages, large towns, and cities, throughout the country. Milk in the winter, and early beef in the spring, always command a high price, and *springers* and farrow cows are bought up in the fall, and fed with this double object in view. As a rule, this class of feeders lose sight of the great fact, that there is a limit to the digestive capacity of their animals; and in their eagerness to produce both milk and beef at the same time, overcrowd the fourth stomach and intestines with a larger amount of nutrition than can possibly be assimilated within a given time. If fine food, like coarse, was remasticated, the loss would be less, for it would have to pass, in small quantities, through the whole process of digestion. If the animal is given all the coarse food it will eat, and that of a very nutritious quality, remastication will nearly furnish all the material that the digestive organs and juices can handle, the system being clogged with a large amount of worthless matter which has to be expelled. Adding to this from four to six and even eight quarts of rich Indian meal at a single feed, to pass into the rumen and by natural processes through all the stomachs in connection with remasticated coarse food, not only insures a great waste in material, but has a tendency to surfeit and sicken, in some cases, the animal. Less coarse food and much less fine, the latter to be given at intervals as far as possible between the feedings of the coarse, will be found to produce more milk and beef, and of a better quality, than can possibly be obtained by the *crowding process*. Whenever, and wherever there is much scouring, there will be great loss. Whenever meal of any kind, or any kind of food which from its nature and condition is not remasticated, is fed, it is all important that it should be as FINE as possible. If fed dry, it is moistened with saliva and passed in smaller quantities into the stomach than if fed

wet; besides the saliva assists fermentation in the rumen; but if scalded or cooked, and allowed to stand until fermentation begins, digestion will be thereby assisted.

For the production of rich milk and butter of superior quality, Indian meal is invaluable to the dairyman; but when he is enabled by its use, to laugh at the calamity of short and defective hay crops, and to use it as a substitute for coarse food under all contingencies, the chief uncertainties and discouragements of his business are overcome; for corn is the most certain crop of our country and seldom fails. Judicious feeding of dairy stock, both while dry and in milk, as well as for the production of beef, will, when practiced, greatly enhance its value. That these pages may contribute to such a result is the earnest wish of the author.

Since writing the above, letters of inquiry have been received from various parties in different sections of the United States, asking for information upon some points not treated distinctly under the foregoing heads, which I herewith answer to the best of my ability.

THE SENSATION OF HUNGER

cannot arise from the absence of coarse bulky food in the first stomach. It is only nature crying out for nutrition. Whenever the organs and agencies of digestion, in the fourth stomach, bowels, etc., have exhausted the elementary constituents of the food last eaten, by carrying them to such parts of the body as are in want, if there is any deficiency in the supplies, a craving arises for more, and this is *hunger*.

The distension of the first three stomachs and the performance of their distinctive functions are not suspended by feeding meal. There is no danger in the

HEATING PROPERTIES OF MEAL

fed as an exclusive diet in the small quantities recommended. If fed in larger quantities over-heating would be liable to arise, as the food once ta-

ken in these, must lay for days, and take its turn in passing out. The "very little" water drunk, when on an exclusive meal diet, demonstrates, that there is no unnatural or dangerous heat generated. I am asked by "one almost persuaded," if it would not be better to feed three or four pounds of

HAY

along with the meal, even if the quantity of meal was reduced? Possibly it might be, but I think not, and I give my reasons as follows: A small quantity of hay, or any other coarse food. would only keep up the old habits which it is desirable to break off. There might not be any loss of food, if this small quantity was given in connection with a small amount of meal, but there would be a great loss of *quiet;* and thus a larger amount of food would be required, to keep the animal in a given condition as to flesh. Another asks, if it would not be better to cut and steam five pounds of hay, mixing the meal with it, and

FEEDING THE MIXTURE TOGETHER?

To which I reply: I can only theorize, never having tested it; but my judgment would tell me that if large quantities of hay and meal were to be fed, for the purpose of getting a large flow of milk, or of fattening an animal, or both, this might be advantageous. Prof. Stewart is a good authority upon this practice. But if light quantities are to be used, to be fed to cows not in milk, I should certainly prefer clear meal.

FEEDING MEAL ALONE

is just as safe as feeding coarse food alone, if proper care is taken to observe the rules laid down in this work.

In reply to several correspondents who inquire as to the feasibility of feeding meal exclusively

ALL THE YEAR ROUND,

I will say that green grass is the natural food of the ruminant. In a state of nature they would only thrive in latitudes where this is constantly available. They are

naturally very plastic. By domestication and variations in climate and food, supplemented with judicious crossing, all the different breeds have been established with their peculiar characteristics. All have become accustomed to living in an unnatural state, upon unnatural food, during our winter months. (I call dry hay an unnatural food) but in the country, when grass again grows, the ruminant roams the fields in a state of nature.

Place them in confinement within sight of green fields, and their natural longing for grass is very strong. You may tempt their appetites with the nicest delicacies, and if you deprive them wholly of grass, they will be uneasy. In the winter months the case is different, and cattle accept the meal in lieu of all other food, with the most perfect quiet and content. Cattle accustomed to stall feeding in summer (as in our large towns, villages and cities), would doubtless accept the meal all the year round; but if cows, giving milk, clear meal would be too heating in warm weather. Diluted with bran, mill feed, buckwheat bran, brewers' grains or other condensed food, it could be made the staple food with great profit. So also cows or other cattle running in pasture, generally eat it with avidity, and

A LARGER NUMBER

can be pastured upon any given field, increasing and rendering very rich the milk product. Where corn is cheap dairying should prosper. The western farmer will learn, after many days, for he is slow at learning, that he can do better with his corn than to sell it from 15 to 20 cents per bushel; while the eastern dairyman will also find, unless he feeds less hay and more meal, that his boasted profits are a *myth*.

Animals which have never been fed meal, may, in some instances, require a short course of preparation before placing them upon an exclusive meal diet. Feed such animals a small allowance daily, in connection with their accustomed food, for at least two weeks previous. When they manifest a preference for meal over hay, it will be safe to withdraw the hay altogether, in most ca-

ses: or the hay may be tapered off by degrees, if the *tapering is not too long.*

It is the experience of the author that calves dropped from meal fed mothers

MAKE SUPERIOR COWS.

As a rule the more the cow is domesticated the better she is for milk, and the more you feed her meal, the more gentle and docile she becomes.

The effect of climate in modifying the wants and requirements of animals as it regards the amount of food necessary to maintain one of given weight in store condition, or while giving milk, has hitherto failed of recognition; but it appears to be taken for granted that the German experiments in feeding have established fixed rules; and that the German ration is THE ration for all times and under all conditions. This is claiming far too much. If the temperature of the stable is changed, the amount of food must also be changed in order to produce uniform results. The uniformity of nature holds only under uniform conditions. Some cattle have a greater digestive capacity than others; some assimilate a larger proportion of certain food constituents, than others of the same size: some take on more flesh and some give more milk than others from the same food. Change the conditions and the contrast is more marked still. All animal life is subject to the same general laws which compel the consumption of large amounts of heat producing food in cold latitudes. The results then, in these German experiments with the cow and the ox, would have varied with any marked change of temperature: so also with different cattle; for no two are precisely alike in their capacity to assimilate food. Mr. John Adams, of Ingersoll, Ontario, (Canada), wintered a herd of 50 cows upon meal exclusively for many weeks, in 1874, which was (he writes me), one of the coldest winters ever known in that region; feeding an average of 4 quarts daily, with no signs of overfeeding; while I, during the same months, a few degrees south of him, was equally successful in

feeding only an average of 3 quarts. The reader will understand from these remarks that a

FIXED RATION

answering for all latitudes, under all conditions, is an impossibility. The *conditions* govern the amount of food required, independent of measure or scales; and the judgment must be used, whether the food is hay or meal, feeding a little less in warm weather than in cold; and if feeding meal exclusively, grading the amount by the condition of the droppings according to the rules heretofore given. For an animal of about 900 lbs. live weight —not giving milk—the mercury ranging from 15 to 20 degrees Fahrenheit, if the stable is as warm as it should be, and as interest and humanity alike require,

3 QUARTS OF GOOD MEAL DAILY

is an ample ration for most animals; but if they can digest more, the condition of the droppings will indicate the fact with unerring certainty, and the ration should be adapted to their requirements.

The *wise* men of this generation, since the agitation of this meal question, have persistently claimed that meal was too *heating* to be fed exclusively; and that it should be diluted with hay or coarse food to counteract "the heating tendency;" and yet they recognize the importance of keeping the stables warm, acknowledging that thereby a large amount of food may be saved; and that shelter and warmth are an equivalent for so much food. The composition of corn is found by analysis (see page 25th) to be exactly fitted to the animal's wants in cold weather. It is rich in carbon, starch and sugar. In the process of digestion starch is decomposed, and its carbon made available, first to sustain respiration and the animal heat, and second to increase the store of fat, but no fat can be made until three primary wants are supplied. Good yellow corn generally contains about 4 per cent. of oil; while hay seldom has one per cent; but the richer the food in oil, the faster fat is laid up by the ani-

mal consuming it. This reiterated objection to meal, on account of its heating properties, is founded then upon *prejudice*, instead of science. No *first-class* scientific man has ever, to the writer's knowledge, raised this objection; neither have they set up the foolish claim that the German experiments in feeding, are in any sense antagonistic to my meal ration: or that they establish an infallible rule for feeding under all conditions.

during cold weather, is in perfect harmony with scientific principles; and the practice is to be condemned or approved from actual results: and these, so far, most happily for the world, and in spite of all the croakers in it, and their name is *legion*, have been highly satisfactory. Feeding meal alone has proved (in every instance yet reported, and they are numerous), where the rules laid down in this pamphlet are observed, just as SAFE, and far more economical than feeding hay alone.

Many letters of inquiry from Dairymen have been received, concerning the propriety of feeding meal during the summer months, to cows running in the pasture; especially when the feed is short, and during seasons of drouth. In reply, I most earnestly commend the practice to the favorable consideration of *all Dairymen.* Whenever from any cause the pasture is short, meal, bran, or concentrated food of some kind should certainly be freely fed. No man can afford to let his cows shrink in their milk production, for the want of food; for no amount of after feeding can restore the flow of milk for the remainder of the milking season. This is not all the damage: it has a tendency to establish a habit in the animal of shrinking her milk ever after, when the same period arrives. If we dry a cow off at the end of 4 or 6 months milking, once, it fixes a habit extremely difficult to overcome in after years. A natural shrinkage always occurs after successful coupling with the male; as some of the lacteal glands are diverted to the support and

nourishment of the *fœtus*. This diversion increases, from necessity, as the *fœtus* grows. No other shrinkage should be allowed to occur during the milking season, which should last from 9 to 10 months. Dairying cannot prove very successful where these natural laws are unheeded.

From a desire to thoroughly test the effects of exclusive meal feeding on my herd, I have abstained from feeding anything but the grass of the pasture, during the summer months, for the last three years; but my neighbor, Mr. John Rhinehart, of this town, has practiced feeding meal during the entire summer, for several years, with marked success. He feeds 100 lbs. meal weekly, to 4 cows, whether pastures are good or poor; and averages 300 lbs. butter yearly to the cow—has tried bran, millfeed, and other kinds of condensed food; and is satisfied that corn meal alone yields the best returns in milk. He laughs at the popular idea that meal is of "*too heating a nature*" to feed cows.

On the other hand, my friend, Mr. O. C. Blodgett, of Fredonia, feeds his herd of 24 cows each their six quarts of bran daily, *both summer* and *winter*; in milk or dry, and claims that it pays him well; that his cows respond to this treatment better the second season than the first; and the third season than the second; reaching their best the third. Many of his herd are grade Jerseys, and he averages about 250 lbs. of butter to the cow.

Many inquiries have also been received concerning

THE WINTERING OF SHEEP

under my system of feeding. I have had no experience in feeding sheep; but the stomachs of this class of ruminants are identical, physiologically, with those of the cow; and I have no doubt as to the effect of an exclusive meal diet upon them. One of the most successful sheep raisers of Michigan, informs me that he has wintered his flock of bearing ewes, almost exclusively upon corn for several seasons; and that he invariably gets much finer lambs, and heavier fleeces of wool, with less casualities, under this treatment than any other. He

adds also, that his wethers when thus wintered, are fit for the butcher very early in the spring. This corresponds with the effects of exclusive meal feeding upon

STOCK CATTLE,

which fatten in an incredible short time (after a winter—or a few weeks even of exclusive meal feeding) when turned to grass in the spring. Those who wish *early* and *cheap* beef, will find this system of feeding *invaluable.*

The author has the satisfaction of announcing also, that he has recently demonstrated the practicability of

FATTENING ANIMALS

upon an exclusive meal diet. The experiment was made upon a two-year-old heifer, at the request of Mr. J. F. Elsom, Agricultural Editor of "The Chautauqua Farmer," to satisfy that unbelieving gentleman, that meal, passes through all the stomachs the same as coarse food; and that these organs are in all respects as healthy under a meal diet, as any other. (A description of the condition of the stomachs will be found upon another page). The animal in question was somewhat thin in flesh when placed upon an exclusive meal diet, the 25th of Dec., 1876. Her rations for the first six weeks was a trifle over two quarts per day—*fed dry*, which barely sufficed to hold her in store condition. The meal was then *scalded*, and the ration increased to 5 quarts per diem, and continued without variation for six weeks longer when she was butchered. Her improvement in condition under the new ration, was very marked and rapid; much more so than any other stall-fed animal which it has been my fortune to see, under a process of fattening, and fed the most approved and liberal rations of coarse and fine food. During this last period she was confined to her stanchion, and *strictly* to the meal diet, and drank less than an average of one gallon of water per diem. During the last 3 weeks, in consequence of her long and close confinement, she became very restless and uneasy; and it was the opinion of those who had been in the habit of watching her closely during the whole period of fat-

tening, that her gains were made mostly during the first 3 weeks; and that she was not as fat when butchered, as she was 3 weeks previous; nevertheless she was found to be in as good condition as animals at that unfavorable age for fattening usually are. Some who ate of the meat fancied that it tasted of the meal; while others thought it unusually sweet and fine. From this limited experience, I am not prepared to say whether the quality of beef, thus fattened, is better or poorer, as food for the table, than beef made in the usual manner of stall-feeding; further tests are needed, and will be duly made; but I am prepared to affirm, that animals may be fattened under this system, CHEAPER and QUICKER, than any other known process of stall-feeding.

From this experiment in feeding, I can confidently recommend to those who have young cattle—or old—that they wish to carry through the winter, without feeding hay or other coarse food, that the young cattle can be kept growing very finely—and faster than by any other known food—by scalding the meal; which obviates all danger from scouring; and that cattle in years, may, in this manner, and by this method, be carried through the winter, or from grass to grass, in just such condition as to flesh as may be desired. I hold this new discovery to be of *immense importance* to the world. There would be no necessity of keeping animals thus fed closely confined; and an hour's exercise in the yard when the weather was fine would be unobjectionable.

It is the author's intention to continue his experiments in meal feeding, collecting and publishing all possible reliable information and data upon the subject; making a work that shall grow in future editions into a larger volume; and which shall be an invaluable text book to all who feed ruminants. Any information of results from those who follow this practice will be gratefully received and duly credited.

TESTIMONIALS.

The following letters are from representative men who are in every respect worthy of confidence:

MORE TESTIMONY IN FAVOR OF MEAL FEEDING.

It is a common remark that "experience teaches a dear school." Sometimes she does and sometimes she does not. Having noticed in The Times the report of Mr. L. W. Miller's lecture on "Meal Feeding," delivered before the Dairy Convention at Meadville, Pa., last January, we concluded to try his plan on a small scale. We selected two cows, one five and the other eight years old—both dry—and, without any preliminary preparation, placed them in a comfortable stable, (where all cows ought to be during these cold winters, meal or no meal), and gave them each three pints of good corn meal, dry, morning and evening, allowing no salt; carried them water twice a day, as they required but little, and seldom let them out of the stable. And here we would remark, as "A Pennsylvania Farmer" thinks they would not be contented, that after the second or third day they seemed perfectly contented and easy, as much so as those beside them getting full "rations," but giving milk. We have seen cattle, yes, and men too, with their bellies a little too full for comfort. We continued this course for ten weeks, when we gradually discontinued the meal, adding a little hay, salt, and grass daily. They dropped their calves, of good size and appearance, in due season. Both cows and calves are doing admirably; in fact, we

never had cows or calves do better. We propose pursuing the same course during the coming winter, whether hay is plenty or not. As we understand Mr. Miller, this plan is not recommended for cows giving milk, but merely for wintering dry cows as economically as possible. Cows giving milk should be induced to eat and digest as much as possible. We say digest, for we have often seen cows fed more than they thoroughly digested, thus making them feverish, lessening the secretion of milk, and deteriorating its quality. W. Beadles.

Cadiz, Ohio.

MEAL FEEDING.

The following letter is sent to us for publication by Mr. L. W. Miller, with the statement that "Mr. Gaylord is a representative farmer of Cattaraugus county:"

L. W. Miller—Dear Sir: I will answer your questions in the order in which you ask them.

1. I did feed seven cows according to your rules laid down in pamphlet—varied only in this: one cow scoured twice, and I gave her a single handful of hay and chaff twice. I fed some five weeks and some ten weeks, according to the times of their coming in.

2. They were, I think, a very little thinner than those hay-fed, and but a very little.

3. Calves all full size and strong; better than from the same cows last spring, when all cows were fed on hay.

4. Milk products rather better than last year, but I think the age of the cows produced the improvement—all the seven but one are six years old this spring, and one five years old.

5. Meal feeding has more than answered my expectations, and is a success.

6. None of my neighbors have tried it. When about to commence the trial of your system, one of my neighbors said to me: "Don't try it on more than one cow—you can't afford to lose seven head, but losing one won't hurt you much." I had in that barn just 14, and told

him I should not lose any. I was satisfied of the fact of your success, and should try it to the end. Then said he, "you'll lose just seven head."

Like everybody else, I had to go from home to learn what my success had been—and learned at the store two miles from my house, that my cattle spent their time lowing for something to eat, and that they were so poor they had to be helped up. At home I never should have learned anything of the kind. The cattle seemed to be contented—drank little, and were to all appearances strong and healthy.

The time is coming when your system will be very extensively adopted by intelligent dairymen. Your rules need no changes or amendments—*they are right.*

Perhaps I should have mentioned that one of the meal fed cows retained the placenta, but it was from a cause wholly foreign to the feed. She did as well as cows do under such circumstances, but seemed to regain her strength sooner than those fed in the ordinary manner.

Versailles, N. Y., June 25. H. C. Gaylord.

ANOTHER REPORT ON MEAL FEEDING.

Under date of Liberty, Sullivan Co., N. Y., July 10th, George Hill writes Linus W. Miller as follows:

In reply to your questions, I will state that I did practice meal feeding according to the rules laid down in your pamphlet, on 14 cows, from January 8th until March 10th, 1876, only varying the ration in case of looseness of the bowels, when I fed a less quantity with satisfactory results.

2. The cows thus fed held their own as to condition fully while thus fed.

3. They came in all right.

4. So far as I have tested their milk product, I am convinced that they have done better than the balance of my herd, which were wintered on hay and grain and were equally as good in former years.

5. The calves dropped were large, fine and healthy.

6. I am glad to say that exclusive meal feeding thus far, has been a success beyond my expectations.

I will state that a portion of my cows got lousy towards the last of my feeding, and as usual these did not do as well as the others—which were in better condition when I left off, than when I commenced meal feeding. You are at liberty to publish this, and I shall be glad to bear testimony at any time in favor of your system of feeding.

To O. C. Blodgett, Sec. W. N. Y. D. Association:

Moon's Station, Chaut. Co., N. Y., June 20, 1877.

In answer to your questions in your letter this day received, concerning the advantages or disadvantages which I have realized from feeding meal on the "Miller plan," I will say that I fed 18 out of 44 head, (mostly dairy cows) for a period of fifty days last winter. With me this new plan has proved a decided success, and I have substantial grounds every time I milk this portion of my herd, for congratulating myself for having tested it. For the first four weeks my meal was finely ground, and my cows gained in flesh; but the last three weeks I fed *contrary to Mr. Miller's rules*, meal that was coarse, under which they lost fully as much as they had previously gained, and I noticed a slight tendency towards scouring; but when put back upon hay, no stranger could pick out the meal fed cows from the herd. Some of the 18 head were heifers, and young, and my judgment is that the meal diet did not answer their wants as well as it did those more advanced in years. They calved all right; the calves were fine, and everything about them was satisfactory. I paid $1.30 per cwt. for the meal, and the cost of keeping was about one-half that of hay at $10 per ton, while the labor of hauling and feeding the meal was only nominal. Now, as to after results: I am getting much more milk from those meal-fed cows than I ever got before—decidedly more than

from the rest of my herd, which were wintered in the usual manner upon hay, the cows all running in the same pasture, and treated alike. Of course I attribute this increased milk production to the meal feeding. My opinion is that this new system of feeding develops in some way—I will not pretend to say how—the milking qualities of the cow, but those who practice it should follow, as nearly as possible, Mr. Miller's rules of feeding, as laid down in his pamphlet.

H. T. Dunbar.

The Stomachs of Ruminants and Their Functions.

The digestion of food is a process of the most varied kind in different animals. In the simple amœba a mass of homogenous protoplasm makes up the entire organic structure, and performs at once the various functions of digestion. As we ascend in the scale of being, we find an increasing difference in these organs as well as those which serve for other purposes with elaborations and subdivisions which bear a strict relation to the habits of the animal and the conditions in which it lives. The difference in the digestive organs of the carnivora and herbivora afford a remarkable instance of this. The first possess a very capacious stomach, in which the highly nitrogenous food is long retained and digested by the secretions of the gastric glands. The bowels are short and of small capacity in accordance with the nature of the food. In the herbivora, on the other hand, which subsist on food rich in carbo-hydrates and comparatively poor in albuminoids, the true digesting stomach is small and the intestines long and capacious. The capacity of the stomach of the dog is three-fifths of that of the entire gastro-intestinal canal, whereas that of the horse is only about two twenty-fifths of the abdominal part of the alimentary tube.

At first sight the ruminant appears to be an exception to this rule, as the gastric cavities amount to no less than seven-tenths of the abdominal part of the digestive canal; but the fourth or true digestive stomach, which alone corresponds to that of the horse or dog, is relatively as small as in the solipede. The first three stomachs are

mainly macerating and triturating cavities, in which the coarse and imperfectly masticated herbage is stored, triturated and partially dissolved, while waiting for further mastication, or for its propulsion into the fourth or true stomach.

FIRST STOMACH.

Of the four compartments or stomachs, the first (*paunch*, *rumen*) is incomparably the largest. It has an average capacity of 250 quarts in the ox, and makes up about nine-tenths of the mass of the four stomachs. It occupies the entire left side of the abdomen, from the short ribs in front to the hip bones behind, and is marked externally by a deep notch at each end, and by two grooves connecting these on the upper and lower surfaces respectively, together with smaller grooves diverging from these, on each side. These notches and grooves correspond to internal folds supported by strong muscular bands, and partially dividing the cavity into a right and left sac, and into interior, posterior and medium compartments. The entire inner surface of this organ, exeepting the muscular pillars, and a small portion of the left anterior sac bordering on the second stomach, is thickly covered by papillæ, mostly flattened and leaf-like, with an elongated ovate outline, but some are conical or fungiform, especially in the left sac.

SECOND STOMACH.

The second stomach, (*reticulum*), though spoken of as a separate organ, is a simple prolongation forward of the anterior left sac of the rumen. It is separated from the rumen by a prominent fold, and the communicating opening is so large that the semi-liquid contents pass freely from one cavity to the other during the movements of the stomachs. Its most prominent characteristic is the honey-comb-like arrangement of its mucous membrane. These cells vary in size and depth, being largest at the lower part of the organ and smaller at the upper, or where it joins the paunch. They extend for a short distance on the surface of that organ as well. The larger

cells are again subdivided by smaller partitions in their interior. The walls of these cells are covered throughout by small, hard-pointed papillary eminences. These cells usually entangle many small, hard and pointed bodies which have been swallowed with the food, and it is from this point that such bodies often pass to perforate vital organs.

ŒSOPHAGEAN DEMI-CANAL.

Connecting these organs with the gullet on the one hand and the third stomach on the other, is the demi-canal, and may be described as the lower portion of the gullet, extending from right to left across the superior surface of the anterior left sac of the paunch and the reticulum, as far as the entrance of the third stomach. But in place of its forming a perfect tube as elsewhere, the lower half of its walls is removed so as to leave a large opening of about six inches in length, communicating with the rumen, reticulum and omasum. The margins of this opening are formed of thick pillars, made up largely of muscular tissue, in part forming loops around the ends of the canal, and in part diverging on the walls of the two first stomachs. This muscle encircles the entire opening, and when contracted as those who advocate a certain theory claim it may be and is brings its lips in close opposition, shutting off all communication between the gullet and first two stomachs, and securing a continuous, unbroken passage from the mouth to the third stomach. When, on the other hand, the muscular pillars of the demi-canal are relaxed, the canal remains open and there is no barrier to communication between the gullet and first two stomachs, or between these stomachs and the third.

THIRD STOMACH.

The third stomach, (*manifolds*, *omasum*), a little larger than the reticulum in the ox, lies over that organ to its right, and above the right anterior sac of the rumen. Its main characteristic is the leaf-like arrangement of its interior. From its walls on the convex aspect twelve or

fourteen folds extend quite to the opposite side of the viscus. In the intervals between these are an equal number of folds of about half the length. On each side of these are others still shorter, and so on until the smallest, which appear as simple ridges on the mucous membrane. In this way the flat surfaces of the folds are brought into close relation at all points in place of leaving larger intervals at the convex aspect of the organ, as would be the case if all were of the same length. These leaves are not simple folds of mucous membrane, but contain also muscular tissue continued from the coat of the stomach, and enabling the adjacent leaves to move on each other for the trituration of the intervening food. Each leaf is studded on both sides with hard conical papillæ hooked upward, and especially prominent towards the free margins of the fold in the vicinity of the passage from the demi-canal to the fourth stomach. Similar hooks with a corresponding direction are found in the lower part of the demi-canal, and all concur in drawing the food upward between the folds and retaining it until sufficiently fine to escape. This organ lies beneath the short ribs on the right side.

FOURTH STOMACH.

The fourth or true digesting stomach (*rennet*, *abomasum*) is pear-shaped, with the thick end forward, and connected with the manifolds. It extends backward in the right flank along the lower border of the rumen, and terminates by a narrow opening in the small intestine. It is considerably larger than either the second or third stomach, but incomparably smaller than the first. Its outer surface shows a number of spiral markings running around it longitudinally, and corresponding to extensive loose folds of mucous membrane, as observed when it is laid open. Its outer surface is redder and more vascular than that of the other stomachs, but its inner lining or mucous membrane is especially soft, spongy and vascular, forming a marked contrast with the pale, opaque, thick and insensible mucous membrane lining the other

stomachs. When magnified, this vascular surface presents throughout a close aggregation of small depressions or alveoli leading into the glandular follicles which secrete the gastric juice.

FUNCTIONS.

The progress of food through the different stomachs can now be followed. It is a wide-spread belief that all food taken by the ox passes first into the rumen, from which it is propelled into the reticulum, is then sent back to the mouth for the second mastication, and is finally swallowed a second time, passing in this case into the third and fourth stomachs. No such regular and invariable course is pursued. After the first mastication of either coarse or fine food—as meal—it is, in swallowing, passed at once into the rumen, which is the natural receptacle of all food of whatever nature. The process of remastication or "chewing the cud," is only performed upon coarse food which is separated from the fine before being regurgitated to the mouth. When swallowed the second time it undoubtedly passes into the rumen again and after commingling again with the contents of that organ such portions of it as are too coarse for the grinding process of the omasum, may be raised again and again. It is possible for very small portions of finely divided food, to find its way when swallowed, directly to the omasum; but the natural receptacle of all food, is the first stomach; and the macerating processes therein carried on, are as essential to perfect digestion, as rumination itself. The size of this receptacle and the large amount which it contains, even after the animal has been subjected to fasting for 24 hours, the act of rumination being carried on during the period, is positive proof that the popular theory of the direct passage of the food, after rumination, to the 3d and 4th stomachs, is an error. The propulsion of liquids through the reticulum, by its contractions, into the demi-canal directly into the omasum, explains how the fine and macerated contents of the rumen find their way into that organ. This, and the

formation of pellets (cuds for remastication) and their propulsion into the gullet with a mass of liquid, for that purpose, would seem to be the essential offices of the second stomach. The large opening between it and the rumen, and the muscular contractions of the latter, by which its contents, solid and liquid, are kept constantly intermingled and floating, show what the normal condition of this organ is; its contents of necessity being identical with those of the former: but from the position in which it lies the volume of contents is small.

The normal condition of the rumen, when the animal subsists upon coarse food, is the constant presence in that receptacle of a mass of solid and liquids equaling at least one-fourth of its live weight; the liquid, consisting of the water drank, in part at least, and more especially of a large amount of saliva secretions swallowed with the food; and sufficient in volume to float the whole mass of solids. When from any cause, as eating a large amount of very coarse, heavy, dry food, in connection with enforced fasting from water, the liquid contents of this organ become insufficient to float the solids, its condition is *abnormal*, and the life of the animal is in danger. When such is the case there can be no rumination. What is popularly termed "the loss of the cud" is simply this, and unless rumination is restored inflammation of a dangerous character ensues.

The use of the 3d stomach (omasum) is simply to triturate and reduce still further the food that has already been partially disintegrated, by rumination, and the macerating processes of the first stomach. The muscular folds seize and retain the solid particles and keep up the grinding process, until they become too fine to be caught and retained by the barbed papillæ. The food, compressed between its muscular folds loses a large portion of its liquids, and becomes, normally, firm and partially dry, though never quite so in health. When dried so as to adhere to the folds and bring off the cuticle layer on its surface, it is abnormal, and "impaction of the manifolds" has commenced..

The abomasum or 4th stomach is similar in most respects to the true stomach in other animals, and performs similar functions. Its gastric juices, acting on the nitrogenous elements of the food, transforms them into peptoms, a fine milky liquid, fitted to be absorbed by and added to the vital fluids. The mucous folds in this stomach, covered as they are by peptic glands, greatly increase the gastric secretions, and enable the animal promptly to digest the large mass of coarse food, so beautifully elaborated by the act of rumination, and the action of the other stomachs.

When the animal subsists upon coarse food the act of rumination is essential to both health and life.

The conditions essential to rumination are, 1st, a sufficiency of liquids in the rumen and reticulum to float the solids; 2d, absence of all excitement; and, lastly, a fair degree of health.

When the animal subsists upon meal, or other food, which, from its nature, does not require remastication, rumination of necessity ceases altogether; and it becomes a matter of profound interest to know just wherein the process of the digestion of fine food differs from that of coarse. We have traced the latter through all of its essential stages, as far as the limited physiological knowledge of the present age extends in that direction; and in a closing article to this little treatise upon the digestion of ruminants, will briefly consider

THE DIGESTION OF MEAL.

Only three years ago the theory of the direct passage of meal and all ground feed into the abomasum, when fed alone, was almost universally acquiesced in by the best agricultural authorities of this country. Its adoption by me, without personal investigation, in the first edition of "Meal Feeding and Animal Digestion," was a grave error. The evidence upon which the popular theory has been rejected in the present edition, I herewith submit to the intelligent reader.

The following communication over my signature, which was widely published in 1875, explains itself:

"I am most happy to be able to announce a discovery connected with meal feeding which, although of no great practical importance in itself, will nevertheless create not a little surprise with the great body of thinking men of this country and perhaps of the world. It has been supposed ever since Profs. L. B. Arnold and E. W. Stewart made their discovery of meal lodged in the fourth stomach immediately after feeding and slaughtering the animal, that M. Flourens and M. Collin were both mistaken in their conclusions about its passage into the rumen, notwithstanding the facilities which those gentlemen had for their very interesting investigations. It will be recollected that each of these men established openings in the side of ruminating animals, by which they were enabled to place the hand beneath the œsophagean canal in the first and second stomachs while the animal was eating, and thus, by the sense of touch alone, decided that the meal passes into the rumen, the same as coarse food. But when it was announced here by the gentlemen above referred to that the meal fed immediately before slaughtering was found in the abomasum, it was supposed that the French gentlemen referred to were mistaken in their observations, and that the evidence of the sense of sight was to be accepted as conclusive. At the suggestion of Prof. Arnold, I have just slaughtered an exclusive meal diet beef, and examined the contents of the several stomachs, feeding meal immediately before killing. I found none of the meal last fed in either the manifolds or fourth stomach, but all, or nearly all, lodged in the rumen, where I found an accumulation of several days' diet—I should judge from five to seven. In the fourth stomach was a quantity of meal, I should judge about the amount I had been in the habit of feeding at one time, in an advanced stage of digestion. This is probably the first animal ever slaughtered upon an exclusive meal diet, and the evidence is overwhelming as to the passage of the meal into the rumen and its subjection there to the law

of rotation which governs that organ in the article of coarse food. It remains to be discovered how, perhaps in the hundreds of examinations made within a few years past, and, with a single exception, the same result obtained, the meal found its way into the abomasum. I see but one solution of the question. It will probably be found upon further research that when the rumen is full, or nearly so, of coarse food, the meal passes on to the third stomach and into the fourth, while it takes the place of coarse food with animals fed exclusively on meal. The death struggles of the animal in question were very violent; and if in any case the meal just swallowed before killing could be forced by those struggles from the first to the fourth stomach, I think it must have produced that result in this instance."

In December of the same year, I made another test, slaughtering in this instance a two-year-old bull fattened in the ordinary way, but placed upon an exclusive meal diet two weeks before the killing. Two quarts of meal was fed immediately before death. The death struggles in this case were very violent and protracted, manure being voided freely at their termination. In cutting the throat, the gullet was severed, and a large proportion of the meal last fed was ejected. (This may serve to explain the difficulty which some have experienced, in finding the meal fed under similar circumstances in any of the stomachs). To prevent any commingling of the contents of the different stomachs, the communication between them was secured by tying, and they were removed before the carcass was raised for dressing. In the rumen were found only slight traces of the meal last fed, but it contained, the same as the first animal slaughtered, several days' rations of meal, commingled with a small quantity of hay, which had apparently been remasticated once. The reticulum contained a few quarts, identical with the contents of the rumen. The omasum was closely packed with meal, and *abnormally dry*; (probably owning to the animal's not having any water for 60 hours before slaughtering). Two days longer (perhaps

less) enforced abstinence from water, would probably, in this case, have produced "impaction of the manifolds." The abomasum—4th stomach—was filled beyond its normal condition, with contents identical with those of the rumen, (careful microscopic examinations of both being made) which had been forced by the violent death struggles through the demi-canal, *past the omasum* (not through it) into that organ. The normal contents of the abomasum—meal partially digested by the action of the gastric juices—was found in the duodenum; and again, the normal contents of the duodenum—chyme were found in the adjoining intestines. The death struggles doubtless occasioned this abnormal condition of the digestive organs; and may serve to account for the contradictory reports of others, who have fed meal before slaughtering, and made examinations of the several stomachs.

In March, 1877, another animal (a two-year-old heifer) fed exclusively upon meal for 12 weeks previous, was killed, having been fattened upon scalded meal for 6 weeks (the first instance of the kind upon record). Adequate measures were taken to prevent her eating anything but her meal rations, during the last named period—meal was fed 30 minutes before slaughtering, none having been fed for 24 hours previously. The killing in this instance was done without any manifestation of death struggles, but the gullet was again severed, with the same results, as to the meal last fed, as related in the previous experiment. It was mostly ejected through the opening along with other contents of the rumen, while the animal was dying. The stomachs and duodenum of this animal were all found in their normal condition under an exclusive meal diet. Several days' rations were in the rumen, containing no traces whatever of coarse food; the liquids bearing apparently the same proportion to the solids, as are found in this organ when the animal has been fattened in the usual way upon coarse food; but with this difference, occasioned probably by the richness of the meal diet; after standing a few hours, it had the appearance

of milk, was very sweet and strongly impregnated with starch, showing the action of the saliva secretions, and the effect of the macerating processes. As the meal last fed had been ejected as before related, its presence was scarcely distinguishable either in this or the reticulum, none of it being found in the other stomachs. Upon handling the stomachs, in their removal from the abdominal cavity, the contents of the first passed freely into the second, and *vice versa*; that this is their usual normal condition, under all kinds of diet, I am satisfied; and think Prof. Arnold mistaken in his supposition of any thing different, or that "meal fed alone stays in the rumen much longer than coarse food." When hay or grass alone is fed, the rumen contains several days' rations; and my observations confirm my conviction that a cow will hold her rations under the macerating processes of the rumen, just as long, with one kind of diet as another; and that the principal office of the reticulum, is the separation of the coarse food from the fine, sending the former back for remastication, and the latter downward, according to the demands of appetite. Nor can I conceive that as a rule, anything is left to chance in the complicated process of digestion. With these remarks I will add, that the stomachs of this animal, after being carefully examined and their contents noted, were forwarded to Prof. Arnold, for examination and report, which was duly received by me, as follows:

ROCHESTER, N. Y., March 23d, 1877.

"MR. L. W. MILLER—DEAR SIR: Yours of the 16th " inst. was duly received. The stomach came to hand " in good order, and has been carefully examined. It " was in every respect healthy and sound. The course " of the meal was evidently through the rumen; and in " general followed the same course as herbaceous food. " The chief difference I notice between this and ordinary " stomachs lies in apparently blotting out the distinctive " functions of the first and second stomachs. They were " evidently, in this case, doing the same duty.

"Taking your measurement of the fluid removed from " the rumen before it came to me, it must have contained " when killed, about 65 lbs. of liquid and solid matter, " which was sufficient to give it a comfortable distension " that would prevent any feeling of uneasiness. There " was no need of analyzing contents of rumen: the liq- " uid is not different from that I have always found, in " the stomachs of healthy animals, not filled with coarse " herbage.

"The inferences I draw from the examination of this " stomach and its contents are:

"First—that the animal was healthy and comfortable.

"Second—that the meal took the course of herbaceous " food.

"Third—that meal fed alone stays in the rumen much " longer than coarse food.

"Fourth—that meal fed alone digests much more thor- " oughly than when the energies of the stomach are di- " vided between meal and coarse herbage.

"Fifth—the animal did not ruminate.

"I have sent a statement to the Tribune*, which will " probably appear about week after next, which see. " Many thanks for your kindness in sending the pack- " age. Respectfully,

Signed, L. B. ARNOLD."

In conclusion, I would further state, that during the season of 1876, I made careful microscopic examinations of the stomachs of 15 different beeves, not meal fed, feeding meal just before the killing and in every instance finding the meal which did not escape through the gullet in slaughtering, in the rumen, commingled with the coarse food in that receptacle. I found too that the normal contents of the abomasum, in a partially digested state, the food being grass and hay, so closely resembled

* NOTE.—The Tribune has published so many *libels* against meal feeding and its author, that it could not afford to print any thing favorable, even if it came from the pen of Prof. Arnold. It holds *prejudice* above TRUTH, speaking only under the dictates of the former. His article never appeared.

meal, that it was difficult to distinguish the one from the other, with the unaided eye.

It would appear then that the only difference between digestion of coarse and fine food, is the continued remastication of the former, until it becomes so fine, like the meal, and is fit for the finishing process of the manifolds.

It would also appear that feeding meal alone insures better digestion than mixing with coarse food; and that all that has been written and said against my system of feeding has had no foundation in scientific principles. Its direct passage into the abomasum, when fed alone, is a myth, and the *cutting, steaming and mixing process in order to get the meal into the rumen*, is a great loss of both labor and caloric; as it finds its way into that receptacle no matter how fed. Finally, the established fact that three quarts of meal, as I feed it, is fully the equivalent of 20 lbs. of good hay as ordinarily fed, simplifies the whole subject; reducing it to dollars and cents. The question is which costs the most, the meal or hay?

NOTE.—In writing the closing article, "The Stomachs of Ruminants and their Functions," the author has copied in part Prof. Law's article published in the June (1875) number of Live Stock Journal.

LIBRARY OF CONGRESS
0 000 894 307 2

Design of Creation.

The author, after years of thought and investigation on the subject of "Creation," has issued a pamphlet, with the above title, containing his views and the conclusions derived from those investigations.

PRICE, TWENTY CENTS.

CAUTION.

Persons ordering either work should give their Names and Post-office address in full, giving County and State.

The usual Discounts made to the Trade.